PERCEPTION OF KEY ACTORS ON THE DRIVERS AND BARRIERS TO CONSTRUCTION AND DEMOLITION WASTE(CDW) MANAGEMENT IN NIGERIA: A ROADMAP FOR THE RECOGNITION OF THE INFORMAL SECTOR

By

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A thesis submitted in partial fulfilment of the requirement of Cardiff University for the degree of Doctor of Philosophy

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December 2023

Abstract

Reuse and recycling of construction and demolition waste (CDW) has the potential to be a major contributor to sustainable construction. Despite Nigeria's significant CDW production, the construction industry has not prioritized sustainable waste management. The aim of this research was to investigate the potential for reuse and recycling of CDW in Nigeria with specific focus on the role of informal waste workers in facilitating this. Informal waste workers play a crucial role in CDW recovery, yet formal efforts are lacking. The study employed a mixed-method approach, including surveys, interviews, and ethnography. Stakeholder perceptions were that incomplete documentation before commencing construction and material offcuts were major waste factors. Additionally, the lack of specific laws and standards for CDW management in Nigeria was highlighted. Barriers and drivers to CDW reuse and recycling in Nigeria were revealed and categorized into political, social, technical, and financial factors in figures 5.2 and 5.3. The ethnographic study details the informal CDW management process, illustrating a roadmap to the informal waste workers roles which had not previously been acknowledged in literature. The study contributes to knowledge by emphasizing the roles of informal waste workers and advocating for policy recognition and social inclusion of informal waste workers. A roadmap for recognizing the informal sector's contribution to CDW reuse and recycling is proposed as a key outcome of the study, with the potential to significantly improve CDW management practices in Nigeria.

Keywords: Construction and demolition waste, Reuse, Recycling, Informal waste workers, Construction waste management policy.

Acknowledgements

I am very grateful to God for the unwavering grace I have enjoyed from the beginning of the PhD journey to this day. For the strength to continue, for the grace to smile each day and for joy in the mist of the storm.

I am forever grateful to my Supervisors, Dr Vicki Stevenson, and Dr Christopher Whitman for their immense contribution to my success. For their intense patience, commitment and directions that guided me in undertaking this research. Their scholarly guidance, constructive comments, feedback, and critical revision of the drafts made it possible for me to complete this thesis. I do not take this for granted! To me you are more than just supervisors – you are a lot more of what I term destiny helpers.

I am also indebted to Dr Chigbu Njike for believing in me and for all your support and encouragement in making sure I got enrolled and funded for a PhD abroad, God will bless you. To Dr Nkechi Ikpeazu, thank you for your support. This journey wouldn't have started without your support. Thank you so much. To TET fund, I am very grateful for the fully funded studentship. I equally thank my proxy observer, Mr. Sunny Agbai, whose support made my fieldwork a success. To all my friends here in the UK and Nigeria, who in one way or the other encouraged me in the process of concluding this work, may you receive help at the point of your needs.

Now to my husband Obinna Onyekwere, for always believing in me, and to my second son, Eze Onyekwere, I thank God for giving me a son like you. For all your technical support, you made this journey a bit easier. You are amazing, and I love you.

God Bless You All.

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List of Abbreviations, Acronyms and Definition of Key Terms

3R	Reduce, Reuse, and Recycle
AEPB	Abuja environmental protection board
BRCW	Basic requirement of construction work
BAMB	Building as material bank.
BIM	Building information modeling
BRE	Building research establishment.
CDW	Construction and Demolition waste
C2C	Cradle to Cradle
CDRA	Construction and demolition recycling association
CPR	Construction product regulation
CE	Circular economy
CPD	Continuous Professional Development
CWDCS	Construction Waste Disposal Charging Scheme
DEFRA	Department of Environment Food and Rural Affairs

DfDF Design for Deconstruction and Flexibility

DfOC Design for Off-site Construction

DOI Diffusion of Innovation

EAA European Environment Agency

EC European Commission

EIA Environmental Impact Assessment

EU European Union

EE Embodied energy

EPA Environmental Protection Agency

FEPA Federal Environmental Protection Agency

FISSAC Fostering Industrial Symbiosis for a Sustainable Resource Intensive Industry across the extended Construction Value Chain

GDP Gross Domestic Product

GHG Greenhouse Gas

GWP Global warming potential

HISER Holistic Innovative Solutions for an Efficient Recycling and Recovery of Valuable Raw Materials from Complex Construction and Demolition Waste

HND Higher National Diploma

HSE	Health Safety and Environment
ICT	Information Communication Technology
IBS	Industrial building system
ISO	International Standard Organization
LASBCA	Lagos State Building Control Agency
LAWMA	Lagos State Waste Management Authority
LCA	Life Cycle Analysis
LCC	Life Cycle Costing
LAWMA	Lagos state waste management agency
LCA	Life Cycle Assessment
LWT	Low waste technologies
MSW	Municipal solid waste
MDGs	Millennium Development Goals
NSW	New South Wales
NBCFs	Nigerian Building Construction Firms
NCI	Nigerian Construction Industry
NEMA	National Emergency Management Agency

NIOB	Nigerian Institute of Building
OND	Ordinary National Diploma
PAYT	Pay as you throw.
PAYT	Pay As You Throw
QDA	Qualitative Data Analysis
RCA	Reinforced concrete aggregate.
RCA	Reinforced concrete aggregate.
RQ	Research Question
SWMP	Site waste management plan
SWM	Solid Waste Management
SMEs	Small and Medium scale enterprises
SD	Sustainable Development
SDGs	Sustainable Development Goals
SWC	Solid Waste Collection
SC	Sustainable Construction
SD	Sustainable Development
SON	Standard Organization of Nigeria
SPSS	Statistical Package for the Social Sciences

SWM	Sustainable Waste Management
SWMP	Site Waste Management Planning
TOPREC	Town Planners Registration Council UK United Kingdom
TPB	Theory of Planned Behavior
TOR	Theory of Recognition
UN	United nation
UNESCO	United Nation Educational Scientific & Cultural Organization
UNHABITAT	United Nations Human Settlements Program
UNEP	United Nations Environment Program
VOCS	Volatile organic compounds
WEF	World Economic Forum
WM	Waste Management
WRAP	Waste and Resources Action Program
WRAP	Waste resource action program
WAI	War against indiscipline
WTE	Waste to energy
WFD	Waste framework directives

ZW Zero waste

Definition of Key Terms

Construction waste: A waste stream produced by construction activities.

Construction waste management: A set of methods and procedures for managing the volume of waste after it is generated.

Circular economy: A sustainable concept that ensures zero waste of materials, low pressure on resource consumption and energy through reuse and recycling principles. It is a waste reduction system that maximizes materials and products.

Construction waste minimization: A set of methods and procedures for reducing the volume waste before it is generated.

Disposal: The collection, storage and/or destruction of unwanted materials and products.

Landfill: A waste disposal site where waste of all kinds is buried.

Pollution: The introduction of a substance that has harmful effects into the environment

Recycling: The transformation of previously used materials into new products to decrease extraction of raw materials.

Reuse: A process where materials and products from the waste stream are used for their original purposes again.

Resource efficiency: An efficient use of natural resources to derive their greatest value.

Scavengers: informal waste workers who search for and collect discarded items for resale.

Zero waste: A concept which promotes the reduction, reuse, and recycling of waste to prevent sending materials and products to landfill.

Preface

Onyekwere CE., Stevenson V., Whitman C., 2022. Towards Circular Economy: The Role of Informal Waste Workers in Reuse and Recycling of Construction and Demolition Waste (CDW) in Nigeria. (Awaiting publication)

CHAPTER ONE - INTRODUCTION

1.1 Chapter Overview

This chapter is an introduction to the whole thesis. It begins with the background to the entire study followed by the statement of the research problem (Section1.2), the aim and objectives of the research (Section1.3), the scope of the research (Section 1.4), the research design (Section 1.6), and the structure of the entire thesis (Section 1.7). The chapter ends with a concluding summary (Section 1.8).

1.2 Background to the Study

Rapid urbanization, economic growth and changing lifestyles, has led to increased construction and accompanying waste disposal. Construction activities produces high volume of construction and demolition waste (CDW), which when abandoned, impacts the environment negatively (Marzouk and Azab, 2014; Kaluarachchi, 2018; Kirschke *et al.*, 2019), but when utilized effectively becomes a potential source of wealth.

CDW management is a critical issue across the globe as proper CDW management has been a major challenge for the construction industry both in developed and developing countries (Oliveira, de Oliveira and Fonseca, 2021). Up to 10 – 30% of all waste materials produced and landfilled in most countries comes from construction activities (Wu *et al.*, 2016; Kupusamy *et al.*, 2019).

For contractors, waste generated in construction sites yearly initiates the result in cost factors such as cost incurred for procurement, transportation and waste disposal (Aboginije, Aigbavboa and Thwala, 2021). To the environment, the impacts of CDW includes water and soil contamination, obstruction of rivers and other drainage channels, degradation of landscapes, propagation of diseases causing vectors such as insects, rodents, etc. (Esa, Halog and Rigamonti, 2017; Ogunmakinde, 2019; Charef, 2022).

As a major driver to construction waste management, governments in many parts of the world have formulated different means of reducing waste streams to landfill (Balasopoulou *et al.*, 2017; Menegaki and Damigos, 2018a; Ghafourian *et al.*, 2021). For example, while making sure that economic growth does not increase waste and pollution, the European Union environmental action plan has made waste management a priority throughout the project lifecycle (Tisserant *et al.*, 2017). Rethinking Construction Tax Force in the UK, Polluter Pay Principle, Zero Waste Scotland proposes that waste should not exist (Rodrigues *et al.*, 2013; Tisserant *et al.*, 2017). There are also well-established technologies for the recovery of CDW, which are in fact cheap and readily available in the developed nations (Gálvez-Martos, Styles, Schoenberger, & Zeschmar-Lahl, 2018)The 2017 UK waste and resource action program (WRAP) states that a good waste material management practice should achieve waste reduction, reduction in disposal cost, increase in performance against corporate sustainability responsibility objectives, increase in competitive differentiation, lower carbon dioxide (CO2) emissions, and meet planning requirements (Aboginije *et al.*, 2020).

Hence, CDW management implies complete eradication of the waste where feasible, reducing the waste where practical, reuse of waste materials, and recycling to reduce the burden on landfills (Aboginije, Aigbavboa and Thwala, 2021). Different CDW management approaches have been successfully applied across the globe. Some of these include:

- Digital construction, e.g., building information modeling (BIM) to reduce waste (Olanrewaju *et al.*, 2020).
- Prefabrication approach to construction waste reduction (Silva *et al.*, 2020; Yang *et al.*, 2022)
- Big data approach in estimating waste generation (Lu *et al.*, 2016; Lu, Yuan and Xue, 2021).
- Circular economy for CDW diversion (Esa, Halog and Rigamonti, 2017).

These would be explained in the literature review section.

Despite the numerous policies and research on CDW management, there is continuous increase in the proportion of landfilled CDW. For example, the Department of Environment, Food and Rural Affairs (DEFRA), revealed that CDW landfilled in the UK increased from 33% in 2010 to 44% in 2013 (Ajayi *et al.*, 2015). The increased waste does not necessarily denote increased construction projects but rather, mismanagement of the waste.

In many developing countries, especially in Nigeria, there is a growing concern over CDW management. Huge amount of CDW is produced in Nigeria but the exact quantity is undocumented (Ayuba *et al.*, 2013; Lase *et al.*, 2023). The standard of waste management in Nigeria is still poor and outdated, with poor collection and disposal systems (Ayuba *et al.*, 2013; Albert, Shakantu and Ibrahim, 2021). The formal CDW system has failed in dealing with these wastes as waste is seen dumped on roadsides, waterways, footpaths, empty lands, dumped during a heavy downpour, etc. These materials are reusable and recyclable, hence, when managed effectively will become a potential wealth of resources but when ignored, will impact the environment negatively (Echendu, 2020).

The most common CDW management practices in Nigerian construction industries is dumping the materials in authorized and unauthorized landfills while some contractors who understand the value of waste resell them as scrap (Asim, Batool and Chaudhry, 2012; Osmani and Villoria-Sáez, 2019). The contractor however, most times, does not fully comply to the construction and engineering laws and regulations because there is not a formal responsibility and there is no specific contract condition to it i.e., the laws and regulations are not seen to apply (in which case there is not a formal responsibility). There is, however, legislation which applied to domestic waste, but are not perceived to apply to CDW (Viljoen *et al.*, 2021). For Nigeria to achieve her part of sustainable development goals (SDGs), will require Nigerian citizens to practice effective waste management going forward (Echendu, 2020).

The major attempts made to recover and reuse CDW have been left with informal waste workers who make these attempts mainly for financial reasons. Being an industry with high material intensity, the Nigerian construction industry can achieve a significant environmental and economic benefit by improving material efficiency with the adoption of an effective waste management strategy such as reuse and recycling of CDW.

The informal sector in most cities of developing countries contributes about 20% savings (or even more) to the waste management budget, meaning that 20% more waste gets recovered (Gutberlet, 2015; Morais *et al.*, 2022). A major opportunity can therefore be found with this. Building on this existing recycling system presents a major opportunity for sustainable waste management. Therefore, informal waste management can be recognized and supported by policy and create a system where both formal and informal systems interact and depend on each other. To this end, this research is aimed at investigating the potential for reuse and recycling of CDW in Nigeria with specific focus on the role of informal waste workers in facilitating this.

Nigeria (the Federal Republic of Nigeria) is often referred to as “The Giant of Africa” because of its economy and population. Nigeria has been known as a regional power in Africa due to its GDP which has become the largest in the whole of Africa (above $500 billion), ahead of South Africa thus, making her the 26th largest economy in the world (Chukwuka G. Monyei a, b *et al.*, 2022). As the biggest country in Africa geographically, the Nigerian population in May, 2022 was 215,861,450 (currently 2.64% of the world population) (Worldometer, 2019). In December 1991, Abuja officially replaced Lagos as the capital of Nigeria (see map of the Nigerian states in Figure. 1.1). Abuja’s population is about 403,000, based on the 1999 estimate (Sesan, 2018).

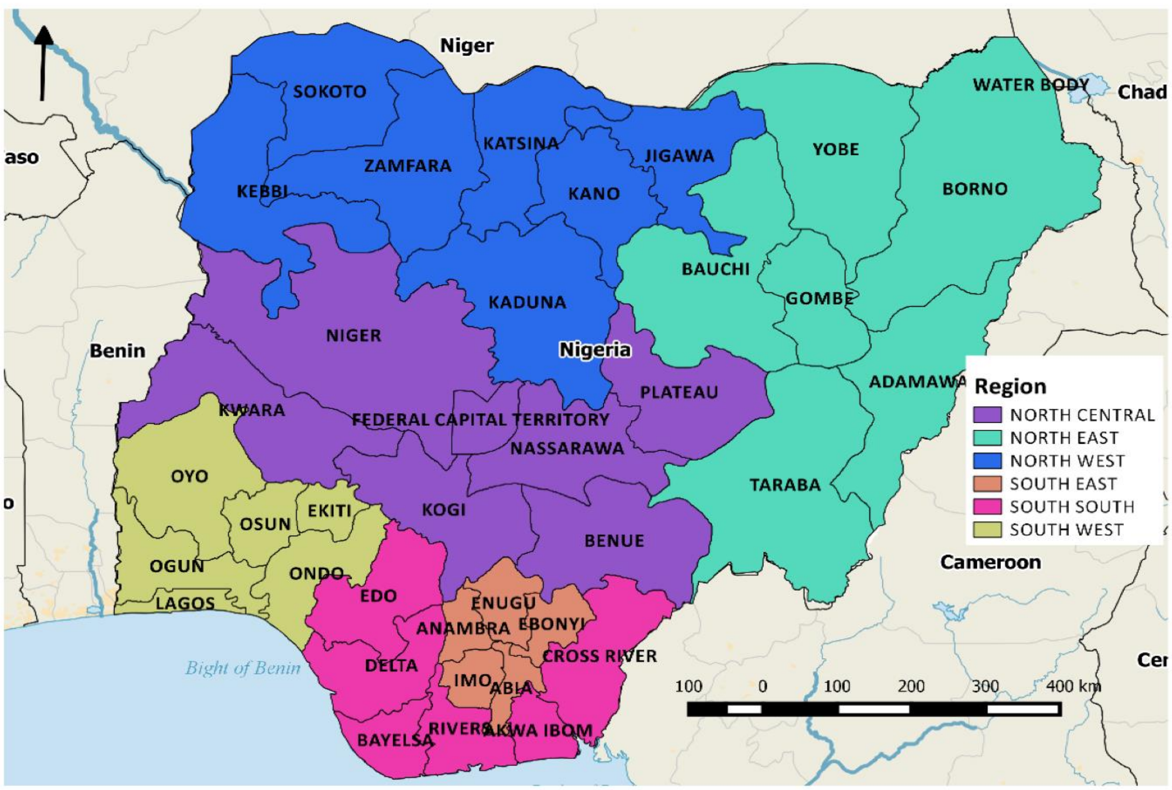

Figure 11 Map of Nigerian states, (Roberman, Emeto, and Adegboye, 2021).

1.3 Research Aim and Objectives

The main aim of this research is to investigate the role of informal waste workers CDW management in Nigeria.

To achieve this aim, the researcher pursued the following objectives:

1. Review best practice relating to reuse and recycling of CDW globally in the context of the existing design and construction processes.
2. Analyse current practices relating to reuse and recycling of CDW in Nigeria.
3. Investigate the barriers to Re-use and Recycling of CDW in Nigeria.
4. Identify the drivers for effective CDW management in Nigeria.
5. Evaluate the role of informal waste workers in the re-use and recycling of CDW in Nigeria.
6. Identify the inter-relationships and needs of the informal sector, as a basis for generating a Roadmap for the recognition of the informal sector in the re-use and recycling of CDW in Nigeria.

1.4 Scope of the Study

The research will focus on understanding the current practices and challenges of reuse/recycling of CDW in the building environment in Nigerian construction industries This sector, apart from generating large amount of CDW, is also low in practicing sustainable waste management among its professionals (Dania et al., 2007). When considering best practices for reuse/recycling, the scope will extend to the UK and the rest of the world.

1.5 Significance of Study

CDW generation is on the increase, especially in the developing countries. This increase has a significant effect on the economy, the environment and human health. Hence, the quest for more sustainable construction waste management methods. Apart from these effects, dealing with waste presents an additional cost (extra cost may be from sourcing virgin materials). Review of CDW management literatures of developing countries has limited studies on reuse and recycling of CDW. Most studies opined that CDW mostly ends up in landfills or dumps which occupy available land. However, reuse and recycling are less frequently used. The limited use recorded are those made by informal actors. Reuse and recycling of CDW can be a major contributor to sustainable construction, hence the need for such studies becomes relevant after sustainable development.

To the CDW scholarship, this study intends to fill the gap in investigating the potential for reuse and recycling of CDW in Nigeria with specific focus on the role of informal waste workers in facilitating this.

Therefore, an in-depth study and analysis of potential utilization of waste in the Nigerian construction industry will create a strong backbone for sustainability in the construction industry and give strong support for green society.

1.6 Research Design

This research focuses on an existing concept; however, the concept is not fully embraced in the country under consideration - Nigeria. This inclines to an assumption that there is an existing means of investigating the potential for reuse and recycling of CDW in Nigeria, whether we have known it or not. Hence, realist ontological belief is suitable for this study. This means that there is an existing truth about CDW management methods, whether they are known or not.

Having established the ontological standpoint, the research employed objective and subjective epistemological approaches. Considering the research aim, a combination of qualitative and quantitative research approaches was employed. At the beginning of the study, the objective approach was necessary to gain an in depth understanding of the concept of CDW management, through an objective communication with randomly chosen Nigerian construction industry professionals. The approach is often employed when little is known concerning the subject. This enabled the use of subjective methods later in the research. Subjectivism claims that no moral truth exists alone, but they are entirely relative to the person. It emphasizes the role of individuals in making history. Hence, the researcher becomes a subjective participant in the research.

The research strategy employed in this study is pragmatism. Pragmatics can employ both positivism and interpretivism philosophy within the same research, thereby integrating multiple research methods such as quantitative, qualitative and action research methods. This denotes that they combine whatever methods necessary to answer the research questions and carry out the research successfully.

Structured questionnaire surveys were used to collect quantitative data, while qualitative data was collected using semi structured interviews and recording of observations/impressions, pictures, and videos.

1.7 Contribution to Knowledge

The concept of CDW management and CDW reuse, and recycling have been established by several studies. Expanding on existing information, as well as getting new insights subjectively, this study seeks to suggest to the Nigerian construction sector, a more sustainable waste management through reuse and recycling by the informal waste workers. The findings from this investigation will help formulate models to manage the substantial amount of CDW emerging from the Nigerian construction sector, reduce material depletion, resource extraction, and pollution. Therefore, this research explores:

i. Global best CDW management approaches as a guide to the Nigerian construction sector.
ii. Waste management approaches practiced in Nigerian construction sector and the behavior of the citizens towards construction waste.
iii. Waste management through reuse and recycling by the informal waste workers

Furthermore, the study contributes to the Nigerian construction sector by:

I. Creating awareness and understanding of waste reuse and recycling as a more sustainable waste management approach than landfilling.
II. Providing awareness to policy makers and the citizens on the wealth in waste and the role of informal waste workers in reuse and recycling and circular economy.
III. Improving professionals’ knowledge and understanding of circular economy and emphasize the need for CDW minimization.
IV. Creating awareness for the formation of construction waste reuse policies and regulations and inclusion of informal waste workers.

1.8 Structure of the Thesis

This thesis is organized into nine chapters. The details are outlined and represented in the figure below:

i. **Chapter one - Introduction** – This chapter is an introduction to the entire thesis as it presents the background of the research. The chapter also presents the aim and objectives, the scope, research methodology, significance of the study and gap in literature.

ii. **Chapter two – Literature review**: This chapter presents a review of the related literature on CDW management.

iii. **Chapter three – Research methodology:** This chapter presents the range of research methodologies employed to answer the research questions and justify their selections. describes the research process and methodology adopted. The chapter began with description of the research paradigm – highlighting the reasons for the choice of pragmatism chosen. Thereafter, the rationale for adopting a mixed method approach is presented. The chapter continued with justification of the questionnaire as the method for quantitative data collection and presented details of the sampling techniques and pre-tested the instrument. The chapter also highlighted the quantitative and qualitative data analysis method and presented the choice of interviews as the qualitative method for data collection and details of target participants, interview structure, pilot survey, and protocol for the interview. The procedure for conducting thematic analysis (the qualitative data analysis method used) is described. Validity, reliability and generalizability of the study’s findings form the crux of the chapter.

iv. **Chapter four – Perception of construction stakeholders:** This chapter presents the quantitative method of data collection. The questionnaire will be used to collect data from construction participants. It also presents the analysis of quantitative data.

v. **Chapter five – Perception of policy stakeholders**: This chapter presents the qualitative interviews method of data collection. Semi-structured interviews will be conducted with policy makers who have a stake in the construction industry. The chapter also presents the analysis of the qualitative interviews.

vi. **Chapter six – Perception of Informal waste workers/ On the ground – the life of informal waste workers:** This chapter presents the ethnographic method of data collection. Informal waste workers were observed and interviewed in their business environment by proxy. The chapter also presents the ethnographic method of data analysis.

vii. **Chapter seven – Needs and interrelationships:** This chapter presents further findings made by reanalysis of the ethnographic data using the theory of recognition.

viii. **Chapter eight** – **Discussion of findings:** This chapter discusses the thesis' findings.

ix. **Research conclusions and recommendations:** This chapter concludes the thesis with highlights on each objective, how these objectives were met, and the conclusion and recommendations from the research.

The structure of the thesis is represented diagrammatically in figure 1.2.

1.9 Chapter Summary

This chapter introduced the thesis where the background of study and research aim, objectives and problems were stated. The chapter also highlighted scope, contribution, significance and limitations of the study. The chapter identified existing deficiencies with CDW management in

Nigeria and proposed means of addressing the problem. The chapter ended with a thesis structure.

The following chapter will be chapter two, which presents the review of related literature on CDW management.

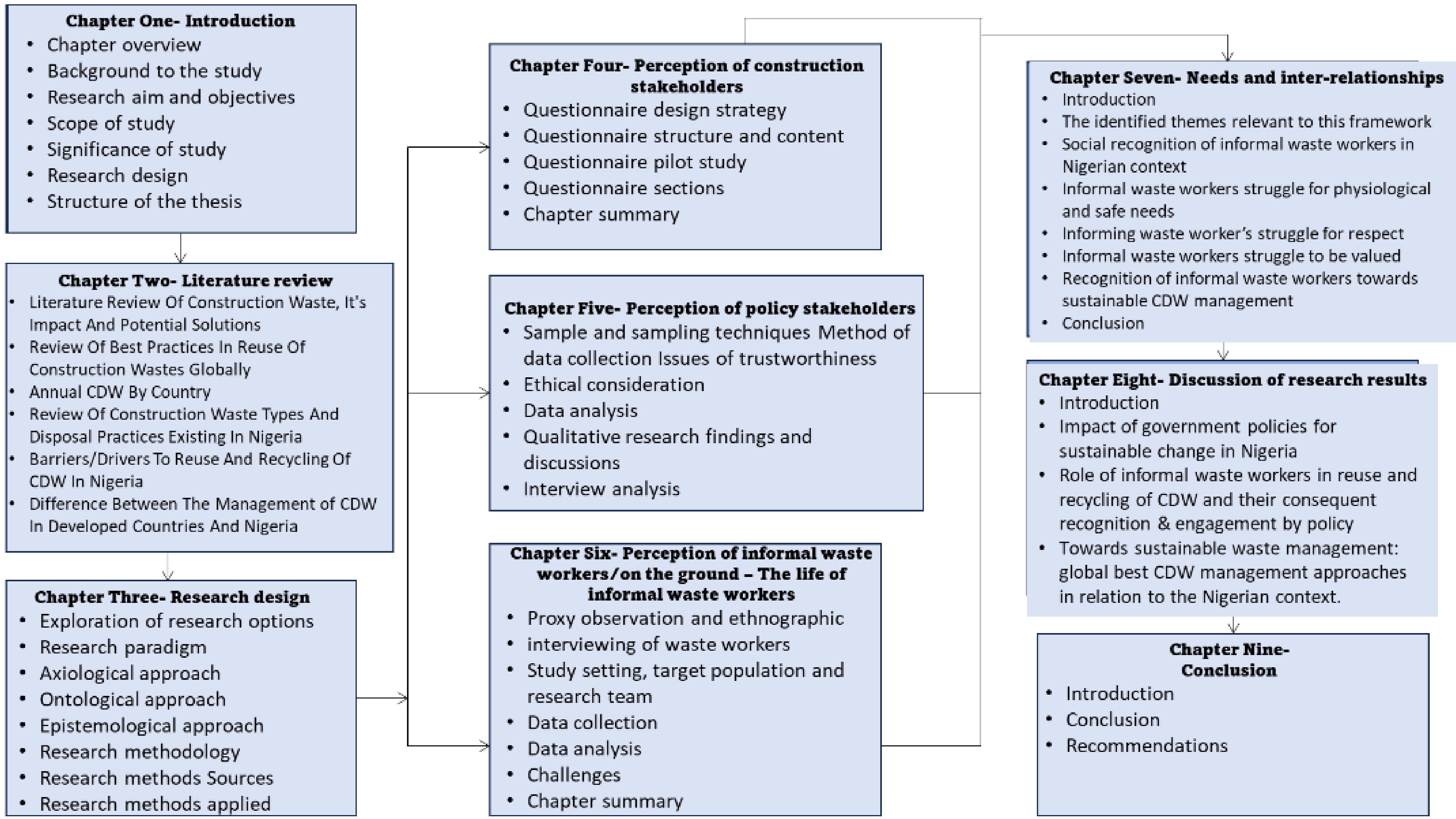

Figure 1.2 Thesis structure

CHAPTER TWO- LITERATURE REVIEW

2.1 Introduction

This chapter considers the issue of construction waste comprehensively. It explores global examples of effective approaches to addressing CDW, emphasizing the hierarchy of “reduce, reuse, recycle or dispose”, before considering the current situation and options specific to Nigeria.

CDW has emerged as a significant environmental and sustainability challenge globally. With the rapid growth of the construction industry, the generation of CDW has reached alarming levels, posing detrimental impacts on the environment, economy, and society. Nigeria, as a developing country, experiencing substantial urbanization and infrastructure development, is confronted with the escalating challenge of managing CDW effectively.

2.2 Review of Construction Waste and its Impact

The definition of CDW varies across countries, making it challenging to compare. However, the understanding of CDW in different countries has largely improved over the last decades (Tam and Lu, 2016).

2.2.1 Amount of construction and demolition waste CDW)

CDW is defined as the solid waste produced in the construction industry; explicitly, the waste that emerges from construction, remodeling and demolition (Caldera *et al.*, 2020).

CDW in any project can take the form of debris from structure demolition, rubble, earth material, steel waste, timber waste, and mixed site clearance materials resulting from various construction activities such as land excavation, engineering and building construction, site clearance, deconstruction, road construction, and building renovation (Ghafourian *et al.*, 2016; Papastamoulis *et al.*, 2021).

CDW relates to excess and faulty materials resulting from construction. It also includes waste materials that are unsuspectingly generated by natural occurrences such as floods, earthquakes, hurricanes, tsunami, etc. (Menegaki and Damigos, 2018b). Further to these, (Duan, Wang and Huang, 2015) explicitly noted that waste from deconstruction processes causes ten times more material waste than actual construction activities. This claim was supported by (Gálvez-Martos *et al.*, 2018) who stated that 90% of CDW can be produced from demolition activities.

(Esa, Halog and Rigamonti, 2017) It also believes that CDW includes wasteful use of labor, material and cash, and material waste. This could likewise add to the waste (as nonphysical waste) and cost overrun because of errors in design and over requesting of materials and defective hardware could likewise add to the non-physical waste.

There is another school of thought that sees CDW to include works that do not add value in construction such as overbuilding. Examples of this include: unnecessarily thick floors, absurd development procedure or idle sitting time (Tam and Lu, 2016). This view can be followed back to Ohno who characterized waste as "any human movement which assimilates assets yet makes no worth" (Nagapan, Rahman and Asmi, 2012), and it was embraced by many lean construction advocators. This view empowers scientists to think about both material waste and works that do not add value. Here, the huge volume of waste produced is because of how the construction business keeps on empowering the direct based practices of ‘take-make-devour arrange'. These waste materials are also too high to construction work spending plan. From this observation, it can be concluded that the amount of CDW in each construction activity is a product of certain internal and external factors. It also states that non-physical waste should also be regarded as waste because their negative effects have monetary value. However, this research will focus on physical waste.

CDW is the dominant waste stream generated across the globe, accounting for about 30-40% by mass of the general waste stream that goes to landfill (Babayemi *et al.*, 2018). These waste materials include concrete, nails, screws, insulation, fixings, wiring, wood, plaster, reinforcing bars, bricks, metals, plastic, pipe work, solvents, excavated soil, asbestos, etc. While concrete is the heaviest waste material, many of the above-mentioned waste materials come in lesser quantity than concrete but have greater impacts.

For this research, the definition of CDW is based on Ghafourians's definition (Ghafourian *et al.*, 2016) but with the addition of Duan's inclusion of deconstruction waste (Duan, Wang and Huang, 2015). Between them, they clearly define the key- questions "What is CDW?", How and Where is CDW created?" which is illustrated in Figure. 2.1.

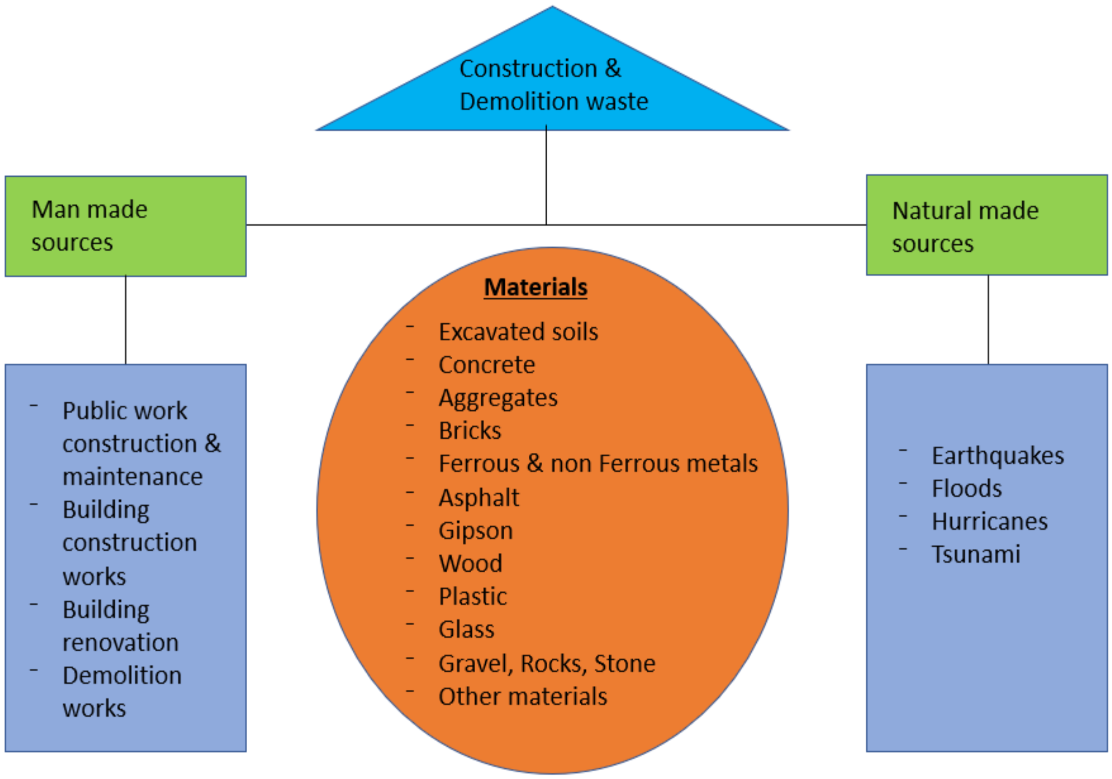

Figure 2.1, Generic classification of CDW according to source of origin, based on Ghafourian et al., (2016) & Duan, Wang and Huang, (2015).

The European Union classified CDW into nine smaller categories according to their potential for recycling (Eurostat, 2020). Other sources e.g. (Silva, de Brito and Dhir, 2017a; Li, Han and Lu, 2018), used a simple classification of: inert, non-inert and contaminated waste.

Inert waste, (which includes solid blocks, concrete, and mortar) contributes the highest amount of CDW. The inert waste can be reprocessed to get reusable construction materials, like coarse and fine aggregate. Non inert waste is biodegradable waste which can decompose e.g., timber. Contaminated waste is hazardous waste which is harmful to humans and the environment when disposed. Examples include asbestos, adhesives, paints etc.

The bulk of inert CDW from demolition activities can be reprocessed to further produce aggregates for new construction. Moreover, when considering the amount of CDW, it was observed that the building internal and external factors affect the amount of CDW produced. Internal factors include the building age, building category, structure of building, technologies used for construction as well as characteristics of geometry. External factors include regional or city plans, regional law, gross domestic products (GDP) and population growth, technical development of construction activities and construction workers management abilities (Wu *et al.*, 2016).

CDW content is also dependent upon the construction site type. For example, building demolition sites produce more concrete waste while road construction sites produce more excavated materials. However, construction activities are heterogeneous, making it difficult to calculate an exact pattern of construction material generation rate of waste type (Mália *et al.*, 2013; Ulubeyli, Kazaz and Arslan, 2017).

The following conclusion can be drawn from this section:

- CDW arises from building and civil works, demolition and renovation works. However, the bulk is from demolition.
- CDW includes inert, non-inert and contaminated waste.
- Nonphysical waste constitutes part of waste, although this research will focus on physical waste.
- The amount of waste is affected by a range of factors such as building internal and external factors.

2.2.2 Annual CDW Globally

CDW is known for its high volume and weight, although its environmental impact per tonne is relatively low due to high inert proportion (Gálvez-Martos *et al.*, 2018). Nevertheless, the large amounts of global CDW production raises significant concerns, due to its environmental impacts, more importantly its land occupation and transportation logistics Gálvez-Martos *et al.,* 2018.

Therefore, prioritizing CDW management has become crucial in environmental programs worldwide.

Extensive research has been conducted on construction waste management (CWM) across different countries, emphasizing the urgency of reducing, recycling, and reusing CDW to alleviate the burden on landfills and promote waste diversion practices (Jin *et al.*, 2017).

Building materials alone account for half of the solid waste materials generated worldwide annually, with CDW production exceeding 3 billion tonnes (Agarwal *et al.*, 2021).

Specific CDW data for selected countries is as follows:

USA

- Over 600 million tonnes of CDW is produced per annum (Mercader-Moyano, López-López and Camporeale, 2022)
- Over 268 million tonnes of waste per annum (Vaughn, 2009; Agarwal *et al.*, 2021)
- 140 million tonnes go to landfills each year (Themelis, 2023)

UK

- 120 million tonnes per annum (Osmani, 2012)
- 29% of solid waste stream is produced by the construction sector (Vaughn, 2009)
- 13 million tonnes per annum of the waste is unused material (Osmani, 2012)

EUROPE

- 820 million tonnes per annum (Gálvez-Martos *et al.*, 2018)
- 46% of total waste generated is from CDW (Gálvez-Martos *et al.*, 2018)

CHINA

- In 2013, 97% of the CDW came from demolition (Zheng *et al.*, 2017)
- 2.36 billion tonnes per annum from 2002-2013 (Zheng *et al.*, 2017)

AUSTRALIA

- 14.3 million tonnes per annum (Park & Tucker, 2016).
- 44% of total waste generated is CDW (Park & Tucker, 2016)

Figure 2.2 is a diagrammatical representation of annual CDW generation for specific countries.

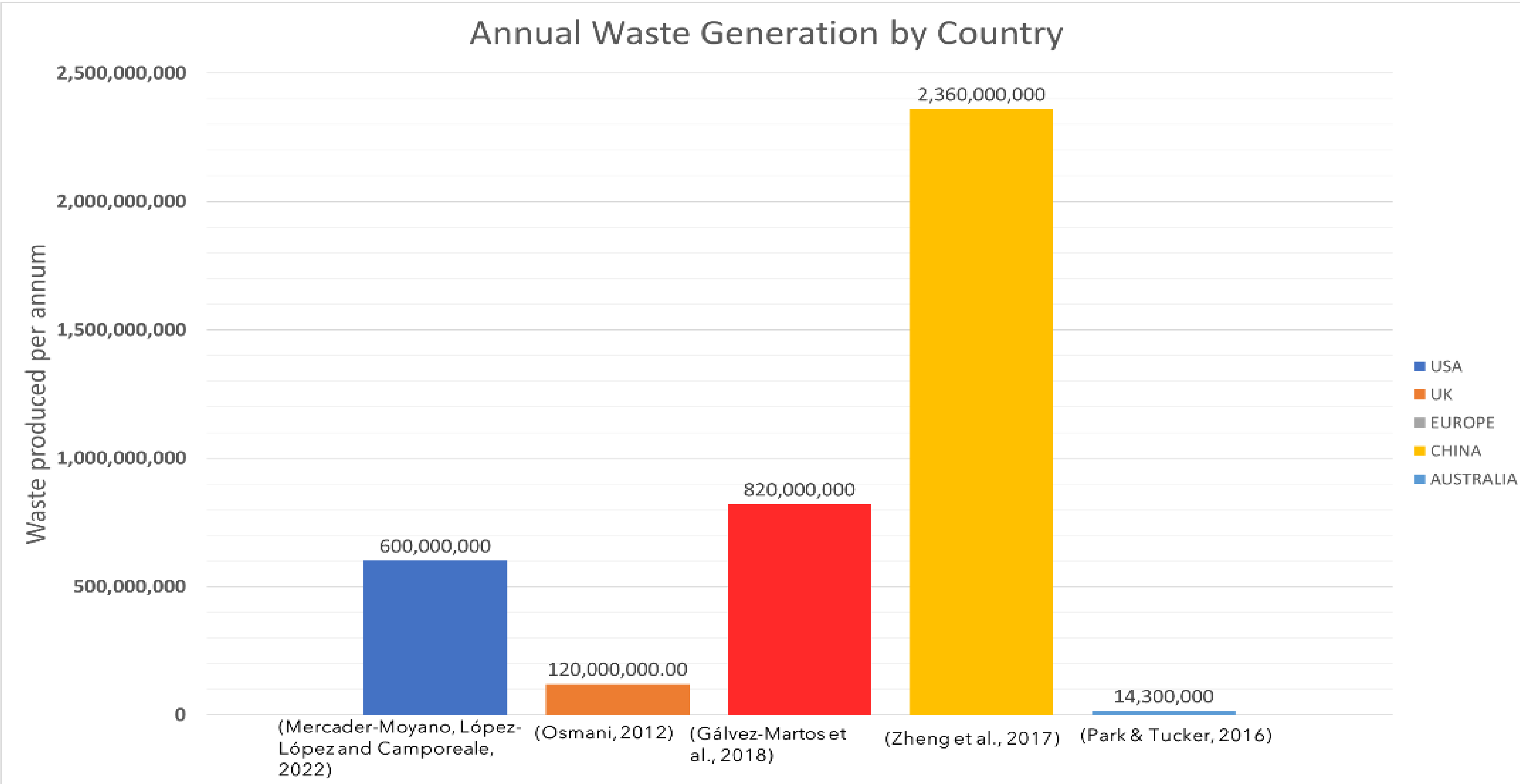

Figure 2.2: Annual CDW generation by country, Adapted from Osmani, (2012), Park & Tucker, (2016), (Zheng et al., (2017), (Gálvez-Martos et al., (2018) & Mercader-Moyano, López-López and Camporeale, (2022).

Analyzing CDW Discrepancies:

Careful observation of the data above shows that there are notable variations in CDW production among countries an over time. For instance, the USA shows various quantities of CDW produced each year, either due to fluctuations in the construction industry or different data sets. Nevertheless, this study has chosen the data set with 600 million tonnes as this is the formal estimated figure by the US Environmental protection agency (EPA)'s fact sheet in 2018 (EPA, 2020).

It is strange to note that the USA produces approximately1/8 of the CDW in comparison with Europe, though having about 64% of Europe's population. These differences might be because of USA's utilisation of more timber materials, which are easier and lighter to reuse at the end of their lifespan. Moreover, the USA has a lot of natural resources, lower transportation costs and available landfill space (Jefferies and Tracy, 2017). Contrary to this, Europe's CDW contribution is closer to global average, probably due to a higher amount of masonry usage. The CDW production for the UK is proportionate to its population within the EU, while China's CDW is higher than the global estimated CDW, indicating different reporting methods or data sources or (Zaman, 2016).

In summary:

Accurate quantification of CDW has remained a great challenge, with differences seen even within countries such as the UK. This is because different methods and approaches are employed in estimating the amount of CDW, most especially assumptions are employed in the process. Regardless of these challenges, it has been proven that CDW constitutes a large amount of the solid waste generated globally each year. Promoting reuse and recycling as part of CDW management should be a priority not only for European countries but for the entire global community.

Figures 2.3, showing UK waste generation by materials and by source will help to further appreciate CDW distribution.

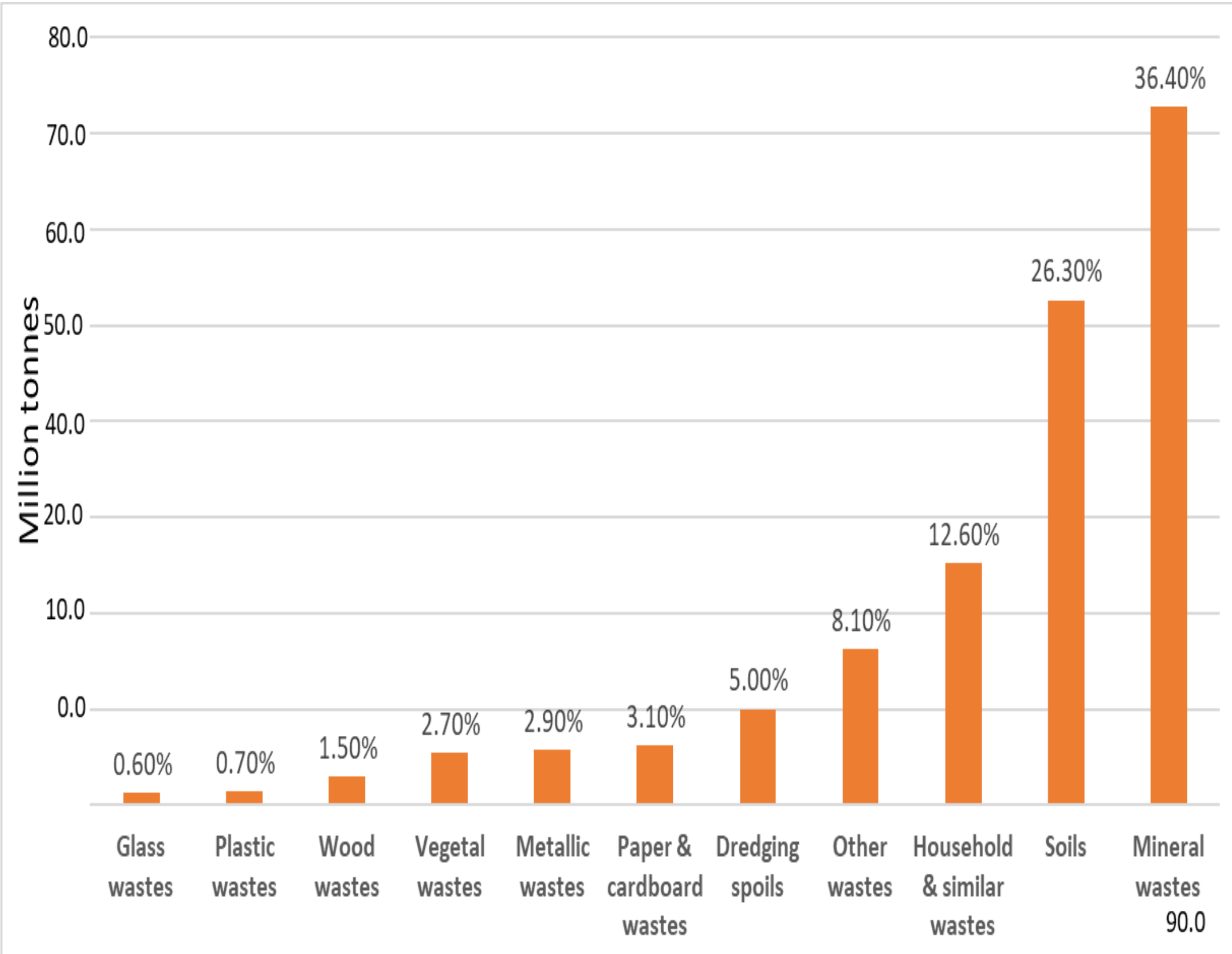

Figure 2.3: UK waste generation by waste materials (data from DEFRA, 2019)

2 .2.3 Effects of construction and demolition waste

The disposal of CDW can have various negative impacts on the environment, society, and the economy. When CDW decomposes, it can release leachates that pollute the soil and water. Even inert waste, such as sand, can generate dust that affects air quality and causes nuisances like dust accumulation on surfaces, windows, cars, and laundry drying areas. Poorly managed landfill sites can exacerbate these problems, particularly if they are not properly enclosed and result in litter being blown away and impacting nearby areas (Chimereze, Omokhudu and Ahijo, 2016; Caldera *et al.*, 2020). CDW also attracts vermin (Kaluarachchi, 2018).

The impacts of CDW on humans and the environment can be categorized into environmental, social, and economic dimensions. The negative environmental impacts associated with CDW production are interconnected, with one impact leading to another.

The negative impacts of CDW are displayed in figure 2.4.

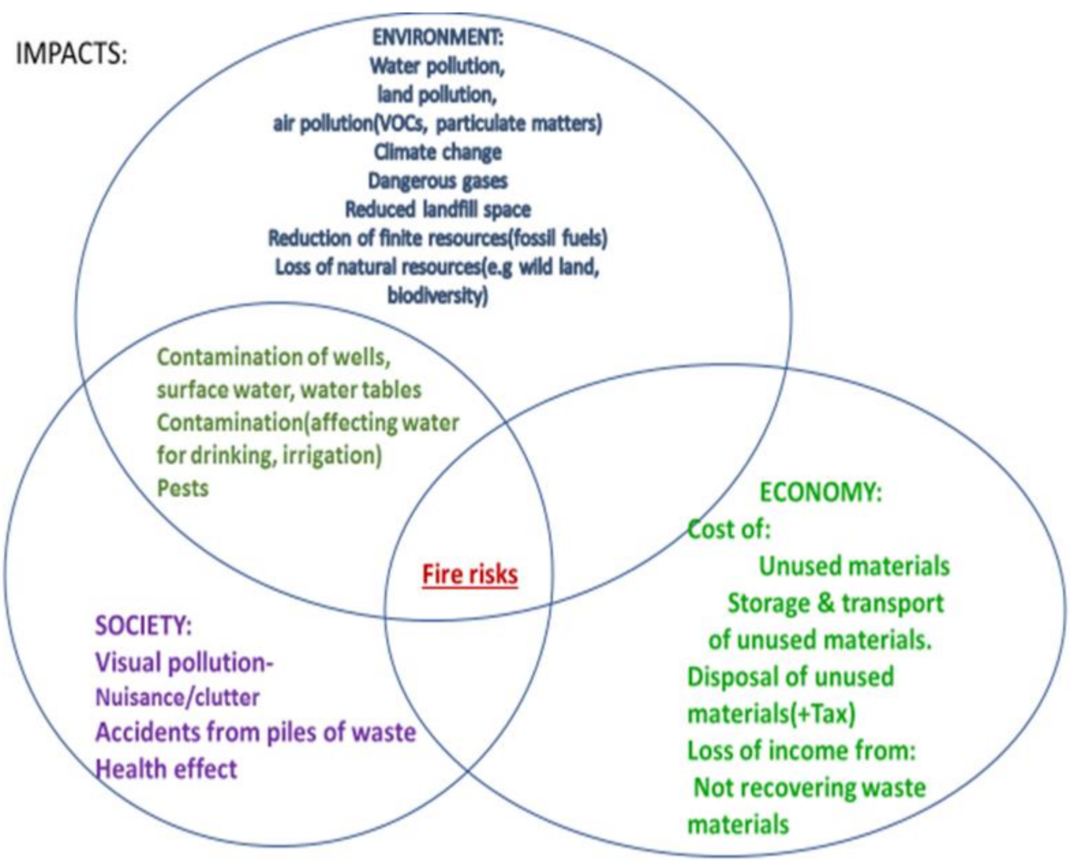

Figure 2. 4 Impacts of CDW (based on Liu, Liu and Wang, 2020).

2.2.3.1 Environmental impacts

CDW has become a major problem for sustainable construction. (Wang, Deutz and Gibbs (2015) opines that environmental concerns influence governmental efforts towards waste management. The environmental impacts listed in figure 2.4 are now discussed below:

<u>*Air pollution and dangerous gases*</u>: When CDW is disposed, it can produce air pollution through decay, particulates, or combustion, all of which can be dangerous to humans. CDW combustion gases include SO2 and NO2, which produce acid rain. Tiny particulates from smoke can also lead to smog. CDW components like plasterboard are hazardous when landfilled. This is because they breakdown to release hydrogen sulphide (a toxic gas) which can cause health issues to humans. Landfilling CDW results in complex mixture of gases (due to microbial action within the landfill) such as CO_2 and Methane as well as other VOCs (volatile organic compounds) which influences climate change. High concentration of gases/pollutants and particulate matter influences climate change and because atmospheric condition determines deposition of gases/pollutants, the effect of climate change on ozone and particulate matter is a great future concern (sangadah and Kartawidjaja, 2020; Kulmala *et al.*, 2023).

Both air pollution and heat waves are associated with increased mortality. An epidemic of deaths occurred during heat waves in Europe between 1990 and 2004. These deaths are attributed to high ozone waves and particulate levels which occurred during the periods of the heat (Marzouk and Azab, 2014). These findings supported by the California Air Resources Board, which stated "*the health effects of increasing concentrations of particulate matter and ozone are: 6500 premature deaths, 4000 hospital admissions for respiratory disease, 3000 hospital admissions for cardiovascular disease, 350,000 asthma attacks, 2000 asthma-related emergency room visits,* *elevated school absences due to respiratory conditions* (Marzouk and Azab, 2014) ". This indicates the potential severity of the impact (though the author did not specify the time/period or population affected). Waste to energy also affects humans, releasing pollutants such as lead, mercury, arsenic, CO_2 into the air. This poses health issues such as cancer, birth defects, and respiratory disease (Siddiqua, Hahladakis and Al-Attiya, 2022). Some non-inert CDW emits greenhouse gas (GHG) through decomposition, thereby contributing to climate change (Bais-Moleman *et al.*, 2018).

Land pollution: When CDW is landfilled, those containing harmful chemicals pollute the soil, thereby causing harm to humans. Land pollution also arises when people dump CDW in public places. In some countries, this approach is illegal, but occurs to avoid landfill charges. It also reduces biodiversity as more land is used for waste disposal. The continuous development process in some countries generates a large amount of CDW. This bulky CDW occupies very large dumping space, leading to the landfills filling up fast, constituting to nuisance and affecting the aesthetics of the area in question when not covered (Silva, de Brito and Dhir, 2017a). CDW is dangerous because it contains harmful substances like asbestos, volatile organic compounds (VOCs), persistence organic compounds as well as heavy metals (Colangelo *et al.*, 2018). These substances are absorbed into the soil, thereby polluting it.

Water pollution: When non-inert or hazardous waste has been dumped in bushes, rivers, open drains, and empty lands, it can result in contaminating wells, surface waters and water tables and causing erosion. CDW pollution can also come as a result of flooding from disposal sites due to blocked drains and degradation of land (Taiwo, 2009; Cruvinel *et al.*, 2019; Echendu, 2020). When CDW is disposed of, some eventually decay and absorbed down below. During the process of decomposition, leachates are produced, which eventually can contaminate water tables and sources.

Energy consumption: CDW leads to an increase in the consumption of energy for new materials manufacturing and transportation instead of utilizing the dumped materials or avoiding their production in the first place. This problem is linked to loss of embodied energy (EE) of the waste which should have contributed to new constructions. EE is the total energy needed to create a building. The construction industry started considering EE when they began carrying out lifecycle analysis of buildings. EE is a significant component in estimating the environmental effect of any development (Azari and Abbasabadi, 2018).

Use of finite resources: Mineral Resources such as Gold, copper, zinc etc. (which are scarce materials) are mined daily. As the available resources reduces, these materials should be recovered from CDW instead of from the mines (Chambart *et al.*, 2018).

2.2.3.2 Economic impact

CDW not only affects the environment but also has economic implications for countries heavily reliant on the construction industry (Luu *et al.*, 2021).

CDW imposes various financial burdens, such as the purchase of unused materials, expenses for storage, transport, and disposal of unused materials, disposal taxes, potential loss of income from waste materials not being recovered, monetary support for CDW research, pilot projects, and demonstration schemes, and the cost of clearing up CDW in the environment (Mudashiru *et al.*, 2016).

Conversely, cost savings can be obtained through waste reduction - it has been estimated that reducing CDW by even 5% can result in up to £130 million cost savings for the UK construction industry (Ghaffar, Burman and Braimah, 2019, 2020). The prospectives of such earnings have resulted in the adoption of waste management practices in some countries' construction sector. (Kaluarachchi, 2018).

2.2.3.3 Social impact

CDW impacts the environment and people's health. Some of these are:

CDW clutter: Poorly managed Landfill sites will cause litter and attract vermin (Mangizvo and Wiseman, 2012). Poorly managed landfills may contain hazardous substances which, when in contact with humans, causes health problems. These health problems can come through chemical poisoning from waste materials.

Visual pollution and accidents: CDW creates aesthetic problems, disturbing visual areas of humans as it causes detrimental alterations to the habitat.

It attracts pets and increases fire risk: CDW streams increase the risk of fire - waste streams produce various chemicals which react through biological processes thereby generating its own heat and eventually leading to self-combustion. It also attracts pests.

2.2.3.4 CDW Impacts - Summary

In summary, CDW adversely impacts both society and environment. It contains harmful substances which, when exposed to the air, soil, or water, produce pollutants, and become a source of danger to both the environment and human health.

The health risks and pollution associated with CDW, including visual pollution, air pollution, heat waves, and accidents. Considering these and the environmental and economic effects, sustainable CDW management is profitable for human health and the environment and economically advantageous for the construction industry and governments. Therefore, this calls for policymakers to address these problems to ensure a sustainable future.

2.3 Solutions to CDW across the Globe

Various solutions exist to address the challenges posed by CDW across the globe. These solutions aim to minimize waste generation at different stages of the construction, maintenance, and end-of-life processes.

Numerous countries have implemented successful CDW management practices. These best practices include waste reduction through design, circular economy, reuse, recycling, energy recovery, and considering landfilling as the last resort (Hettiarachchi *et al.*, 2018; Luu *et al.*, 2021). By reviewing these international examples, valuable insights can be gained to inform CDW management strategies in Nigeria.

Waste reduction efforts can be categorized into source reduction and end-of-pipe reduction. Source reduction focuses on strategies implemented before waste is generated, while end-of-pipe reduction deals with waste management after its generation. Source reduction, such as adopting cleaner technologies, promotes resource efficiency and provides direct financial benefits by improving profits and lowering costs (Wu *et al.*, 2016; Hong Yang, Junqiang Xia, Julian R. Thompson d, 2017). End-of-pipe solutions can also offer economic and environmental benefits, including increased rates of reuse and recycling, reduced landfilling, savings in land resources, and decreased transportation and disposal costs (Ding, Wang and Zou, 2016).

This analysis will consider the waste reduction options throughout the full process, starting with design (Section 2.3.1) and circular economy concepts (Section 2.3.2) before considering “end of pipe options” (Section 2.3.3-2.3.7).

2.3.1 Waste management through design

Minimizing CDW during the design and planning stage is considered one of the most effective waste management approaches (Esa, Halog and Rigamonti, 2017; Huang *et al.*, 2018). This has been further reinforced by (Olanrewaju and Ogunmakinde, 2020), who indicated that the most significant impacts of CDW arises from design choices toward the beginning of the development value chain. A term used for CDW management is "designing -out waste" and this denotes the designing and planning economically assessable method to stay away from waste generation (Gálvez-Martos *et al.*, 2018). On the other hand, it has also been proven that CDW can be properly managed through design for deconstruction and flexibility. A flexible design can adapt to internal and external changes.

The key word here is “deconstruction” where the building components are carefully dismantled. This differs significantly from “demolition” which is more common. Consideration of deconstruction during design and construction gives a higher likelihood that materials are reused or recycled rather than landfilled.

Designers can adopt waste minimization practices, while training programs should be provided to support this approach (Pericot *et al.*, 2017; Li, Han and Lu, 2018). Waste management considerations should extend to the procurement stage, addressing issues such as packaging waste, material selection, and supplier partnerships that prioritize sustainable practices (Esa, Halog and Rigamonti, 2017).

Design Stage Waste Management Tools:

For effective CDW management, the construction industry has come up with different measures to predict likely construction waste. These are tools used at the design stage to check the waste that can possibly emerge during the construction stage.

One of the most popular tools used in the UK to predict waste is “Net Waste”. which was developed by UK WRAP (Ajayi *et al.*, 2015). It can be used to help project designers select suitable means of improving the project's waste effectiveness. Building /civil engineer's Design Out Waste Tools is another waste management tool (Ajayi *et al.*, 2015).

2.3.2 Circular economy: A Sustainable Approach to Resource Management and Waste Reduction

The circular economy concept is an exemplary strategy for achieving waste reduction and sustainable management of resources (Esa, Halog and Rigamonti, 2017; Huang *et al.*, 2018). It provides an all-inclusive approach that can be applied throughout the development process. Circular economy begins in the design phase by identifying reused/recycled materials and applying design for minimum waste during construction and as reuse/ recycling of waste and materials at end of life (see Section 2.3.1). To determine the prospective for reuse of building materials, their disassembly potential should be examined (Durmisevic *et al.*, 2017). Building parts that can be easily dismantled allow for adaptability and future reuse (Lismont and Allacker, 2019).

The circular pavilion, known as the circl, (Figure 2.5) represents as a principal example of circular economy construction. This exceptional building, located in Amsterdam, was designed with a circular vision and contains glass and wood elements originating from recycled materials. It incorporates the principles of high-quality material recycling, minimal waste generation, and zero energy consumption, reflecting the principle of the circular economy (Bertino *et al.*, 2021). Ayodele, Alao and Ogunjuyigbe (2018) confirmed that this circular economy focuses attention on ease of reuse but went further to show that it can also back the goal of realizing zero environmental impacts. The circl pavilion demonstrates this by incorporating different reuse practices, such as reusing frames from an old office building, insulating the ceiling with recycled jeans and using previously used furniture. In addition, the pavilion uses solar panels and direct current (DC) for energy efficiency and uses a rooftop garden to support biodiversity (Bertino *et al.*, 2021).

Figure 2.5: The Circl: A completely circular pavilion. Material district, (2017). Available at: https://materialdistrict.com/article/circl-circular-pavilion

2.3.3 Reuse: Maximizing Resource Efficiency and Waste Reduction

The European Commission's Waste Framework Directive recognizes reuse as the utilization of materials or parts that are not waste for the same purpose for which they were originally intended (Akinade *et al.*, 2016). Other sources, however, use a slightly broader definition of reuse - the continuous use of CDW materials without reprocessing (but not necessarily for the same use)

(Menegaki and Damigos, 2018a). This research will adopt the second definition as it is more applicable to the whole sections.

Reuse is preferable for waste reduction due to its lower energy requirements (Menegaki and Damigos, 2018a). Because it uses less energy, produces fewer pollutants, and maintains the embodied energy of the original materials, reuse is a more economical and energy-efficient option to recycling (Pittau *et al.*, 2020). By using this method, materials are removed from waste stream and can be used again without being subject to restrictions on their use that could otherwise apply to recycled materials (Hobbs and Adams, 2017). Recycling should only be used when reuse is not feasible (Park and Tucker, 2017).

CDW reuse and recycling significantly affects the overall environmental performance of construction projects (Gálvez-Martos *et al.*, 2018). Despite the increased transport needs associated with reuse, it can save approximately 40% of embodied energy compared to using new materials (Gálvez-Martos *et al.*, 2018). For instance, reusing prefabricated slabs, can save up to 90% of energy compared to producing new ones (Tam and Lu, 2016). Building material reuse like timber, bricks, concrete, doors and windows lowers waste and also preserves valuable resources and reduces new materials demand (Gálvez-Martos *et al.*, 2018).

In addition to the environmental benefits, reusing materials can also provide financial benefits. Reclaimed materials are often available at lower costs than new materials, making them an attractive option for cost-conscious projects (Hobbs and Adams, 2017). Moreover, CDW reuse can, stimulate local economies, create job opportunities and support the creation of a circular economy (Bains, Hongyi and Jialong, 2019; Oliveira, de Oliveira and Fonseca, 2021).

To ease the reuse of building materials, it is important to establish effective systems for identifying material, material storage, and distribution. BIM (Building Information Modeling) technology presents an important role in managing and tracking reusable materials throughout their lifecycle (Ma, 2018). BIM can supply comprehensive information about the characteristics, location of materials, condition, and making it easier to identify suitable materials for reuse and integrate them into new development projects (Charef, 2022).

2.3.4 Recycling

Recycling CDW is essential for sustainable waste management practices. It has significant social, political and economic implications (Ghafourian *et al.*, 2021). By separating and recycling the waste materials generated during construction (Mudashiru *et al.*, 2016), we can unlock benefits and opportunities for improvement in Nigeria.

Across the globe, there has been a focus on research and innovation in the field of using recycled aggregates to meet the durability and mechanical requirements in construction projects (Colangelo *et al.*, 2018). For instance, the successful implementation of using recycled aggregates derived from CDW like rubble as a component of concrete can be seen in projects such as the office complex in Darmstadt, Germany (Park and Tucker 2017; Gálvez Martos et al., 2018). These real-life examples demonstrate how recycling contributes to construction practices while reducing the need for materials.

The primary benefits of substituting materials, with recycled materials include;

- diverting waste from landfills (Bertino *et al.*, 2021).
- reduced resource use and processing (Ma, 2018; Ghaffar, Burman and Braimah, 2020)
- reduced carbon emissions (Rose and Stegemann, 2018)

- preserve the environment by reducing the need for resource-intensive extraction, transfer, and processing activities (Marrucci *et al.*, 2017).
- potential to create job opportunities and generate financial gains (Ferronato *et al.*, 2018; Gálvez-Martos *et al.*, 2018).

Research efforts have focused on economic evaluations and feasibility studies of recycling plants, to promote the advancement of CDW recycling. A study in Portugal Silva, de Brito and Dhir, (2017b) assessed their financial viability and examined factors such as the initial investment required, return on investment, and revenue potential revealed the high profitability of CDW recycling, with a potential return on investment within two years, despite the absence of specific government policies supporting recycling (Silva, de Brito and Dhir, 2017b).

Recycled aggregates, such as crushed concrete or reclaimed asphalt pavement, can replace virgin materials in various construction applications, reducing the demand for new resources (Tam, Soomro and Evangelista, 2018). Furthermore, by integrating recycled materials into construction products and advocating for the utilization of made components we can actively contribute to waste reduction and the preservation of valuable resources (Ajayi *et al.*, 2017).

In the EU, there are specific recycling rate targets for CDW, with a 70% recycling rate by volume being required for non-hazardous CDW (Gálvez-Martos *et al.*, 2018). However, a few countries, like the Netherlands, Denmark and Japan have achieved recycling rates exceeding 90%. This demonstrates the potential for achieving levels of recycling (Carl and Fedor 2016). These countries have implemented recycling systems that cover types of waste. As a result, there has been a reduction in waste generation and its impact on the environment.

Despite the benefits and environmental advantages of recycling CDW some developed countries are facing challenges in meeting their recycling targets (Hobbs and Adams 2017). To improve CDW sorting and recycling practices, economic evaluations and incentivization strategies have been employed (Hettiarachchi et al., 2018). In countries like the United Kingdom, recycling and other forms of recovery methods have become the applied final treatments for waste (Tam and Lu 2016).

However, there are limitations that hinder the growth of CDW recycling sector. Concerns about the quality of recycled aggregates pose challenges to this sector (Oyedele *et al.*, 2013; Hobbs and Adams, 2017; Jin *et al.*, 2017). To overcome these challenges and promote innovation in CDW recycling sector, various research programs have been initiated. The HISER project, which was initiated in Europe in 2015 has the objective of developing affordable solutions to recover raw materials from complex CDW (Hobbs and Adams, 2017). Through the implementation of circular economy principles, the project aims to optimize the process of building construction starting from dismantling existing structures to constructing ones (Bonfante *et al.*, 2021).

2.3.5 Prefabrication

Prefabrication, also known as offsite building, offers opportunities for reducing CDW (Bertino *et al.*, 2021). This method involves manufacturing building components or entire structures in a controlled environment before they are assembled on site (D'Oca *et al.*, 2018). The prefabricated parts are designed to be assembled and disassembled, promoting material reuse and recycling (Silva et al., 2020). By optimizing material usage and minimizing on site activities prefabrication helps minimize construction waste (D'Oca *et al.*, 2018). Moreover, it enhances quality control accelerates project timelines and improves construction efficiency (Minunno *et* *al.*, 2018). Encouraging the adoption of prefabrication techniques is crucial for reducing CDW generation requiring collaboration between governments and industry stakeholders.

An illustrative example of the application of prefabrication in the UK can be seen in the Middle Havens Hotel building techniques. By utilizing precast materials precast columns, volumetric pods and foundations of traditional construction methods significant cost savings were achieved—avoiding almost three quarters of the predicted CDW amounting to more, than half a million euros (Gálvez Martos et al., 2018).

2.3.6 Energy Recovery

Energy recovery, also referred to as waste, to energy (WTE) is a technique that converts recyclable CDW into fuel, heat or electricity through various processes like gasification, combustion, anaerobic digestion, pyrolysis and landfill gas recovery (Forecast *et al.*, 2016). The Waste Framework Directive of the European Union aims to recover 70% of the energy from CDW (Zhang *et al.*, 2022).

There are advantages associated with energy recovery from waste;

- Diversion of CDW from landfills
- Reduction in greenhouse gas emissions by avoiding the burning of fuels for energy generation (although this may not hold true for all energy recovery methods).
- Availability of a fuel source

Incineration is a popularly used waste to energy method for waste treatment. It involves heating waste materials to convert them into fuel, gas, heat and ash (Kaur, Bharti and Sharma 2021). The primary purpose of utilizing the generated heat is electricity production. However, there are concerns about the impact and health risks associated with incineration in countries where older incinerators were constructed without proper separation units for recyclable and non-recyclable materials prior to combustion.

For more than a century, nations like the Netherlands, Sweden and Denmark have successfully utilized combustion-based energy recovery from waste. They have mainly used lower quality waste wood as a fuel source to generate electricity. While waste incineration is often promoted as a waste disposal method, recent research challenges this notion. Studies indicate that burning waste to produce power of recycling materials like glass, cartons and plastic leads to the generation of waste in the form of toxic gases. This approach also hampers efforts to conserve resources (Zero Waste Europe, 2018). Nations reliant on waste incineration tend to have recycling rates. In Denmark specifically areas, with incineration rates exhibit recycling rates and vice versa.

Furthermore, combustion-based energy recovery does not align with the principles of a economy and is not considered a renewable energy source. Although converting waste into energy is a process it contradicts the idea of an economy by depleting valuable resources and increasing the harmful nature of waste—essentially exchanging one type of waste for another.

2.3.7 Waste disposal as a last resort

After production, significant quantities of CDW are primarily deposited in landfills and dumpsites (Ding, Wang and Zou, 2016; Papastamoulis *et al.*, 2021). Globally 35% of CDW is directly landfilled, with varying proportions across countries (Osmani and Villoria Sáez, 2019). Construction and demolition activities contribute around 10-30% of the waste materials dumped in landfills (Kaluarachchi, 2018). The percentages of CDW being sent to landfills in nations are as follows; USA (30%), Brazil (40%), Canada (27%), and Hong Kong (25%) (Menegaki, M. and

Damigos, 2018). In the UK over half of CDW is disposed of in landfills while only about one third of CDW in Australia ends there for disposal purposes (Kaluarachchi, 2018).

Encouraging individuals to recycle by implementing charges for waste disposal can be one of the methods to reduce CDW while also lowering the cost associated with its disposal.

However, a study conducted by (Wang *et al.*, 2018) revealed that the fees for disposing of waste are often insufficient to motivate people to change their behavior towards reusing and recycling. These fees are commonly focused on municipal waste rather than CDW. Furthermore, the economic and environmental impact of CDW is not considered when determining the disposal charges.

Taxes can be used as a measure alongside disposal fees. Governments in developed countries have successfully diverted waste from landfills by adopting the "Pay as you throw" (PAYT) approach, as highlighted by Ajayi *et al.*, (2015). Under PAYT, charges are imposed based on the weight or volume of waste being transferred to disposal sites. Studies from countries such as the UK, Canada, Sweden, the Netherlands, Greece and Switzerland have shown that this approach has effectively reduced landfill waste (Brown and Johnstone, 2013; Ajayi *et al.*, 2015; Ogunmakinde, Sher and Egbelakin, 2022). In the UK specifically a landfill tax with two bands was introduced in 1996. The standard tax rate was set at £7/tonne initially with a charge of £2/tonne, for waste. As of April 1st, 2023, this standard rate has gradually increased to £102.10/tonne. The cost for handling waste has only gone up to £3.25 (Seely, 2009; Villoria Sáez and Osmani 2019). As a result, some construction companies have formed partnerships with waste management and recycling businesses to assist them in sorting and processing waste to minimize the amount that ends up in landfills.

Other construction firms have evaluated waste management strategies, such as low waste technologies, sorting and recycling methods, optimizing materials and in time delivery. They have chosen the cost-effective approach for their needs.

2.3.8 Global Best Practices - Summary

In summary, effective solutions for CDW include reducing waste through design considerations, prefabrication techniques adopting circular economy principles promoting reuse and recycling practices utilizing energy recovery methods while considering disposal as a resort. Waste reduction should be integrated into the construction process from design to end of life stages. Factors like landfill charges technology implementation for CDW monitoring play roles in facilitating the transition towards reuse and recycling.

However, several obstacles hinder the reuse and recycling of CDW. There are obstacles to overcome when it comes to managing CDW. These include the presence of workers, disposal fees, underdeveloped recycling regulations, limited markets, for recycled materials additional costs associated with reuse and recycling efforts inadequate regulations and economic incentives and a lack of awareness about waste reduction.

Furthermore, the reuse and recycling of CDW can have impacts on job creation and skill development in the waste management and construction industries. As the demand for waste management services and recycling facilities increases new job opportunities can emerge in areas such as recycling facilities, sorting facilities and material recovery facilities. This can contribute to reducing unemployment rates and improving the conditions in communities.

From a perspective implementing CDW reuse, and recycling techniques aligns with government policies aimed at waste management, environmental protection and sustainable development. By promoting an economy and resource efficiency through supporting laws and regulations for CDW reuse/recycling practices governments demonstrate their commitment to addressing concerns while also fostering a favorable business environment that encourages sustainable practices within the construction sector.

In addition to these benefits there is also potential for cost savings and financial gains by embracing CDW recycling/reuse initiatives.

Construction companies can reduce their dependence on resources by reusing materials on construction sites and incorporating recycled materials into new projects. This approach does not save money when purchasing materials but also promotes the development of recycling facilities and markets for recovered CDW. It creates business opportunities for entrepreneurs while supporting the growth of a recycling industry (Oyedele et al., 2018).

Moreover, the availability of recycled materials can contribute to prices and lower construction costs making sustainable construction techniques more accessible and affordable. This in turn enhances the competitiveness of the construction sector. Attracts funding for environmentally friendly initiatives. Additionally reducing waste disposal expenses such as landfill fees positively impacts construction budgets and financial performance (Oyedele et al., 2018). By adopting these practices, we can mitigate the effects of construction projects, conserve resources minimize waste production and create more resilient surroundings.

2.4. Global examples of construction and demolition waste reuse and recycling

Both CDW reuse and recycling are common waste management practices. CDW reuse, such as reuse of concrete, bricks, excavated soil, metal, and wood are a few examples that are presented below.

2.4.1 Concrete:

Concrete waste, depending on the type of project, accounts for about 40 to 85% of CDW (Gálvez-Martos *et al.*, 2018). Buildings constructed from precast and prefabricated concrete generate less waste and have benefits including quicker construction, greater quality, better site management, and less demand for on-site plants.

Recycling waste concrete as aggregate has proven to be a method for patching potholes on highways in Nigeria (Amadi and Chijioke, 2018). However, the use of recycled aggregate (RCA) faces challenges in Europe due to the cost of extracting natural aggregate (Gálvez Martos et al., 2018). Nevertheless, in projects,

RCA can completely replace virgin aggregate (Adams et al., 2016; Hobbs and Adams 2016).

Figure 2.6 illustrates the reuse of concrete, for retaining walls.

Figure 2.6: Concrete reuse for retaining walls. Diy garden projects, 2024 (https://www.gardendesignstories.com/blog?tag=diy+garden+projects)

2.4.2 Bricks

Bricks waste can be recycled for decorative applications, such as for facing works (whole bricks) and as a foundation for green roofs (crushed bricks) (Naranjo, A., Colonia, A., Mesa, J. and Maury-Ramírez, 2020). The choice of mortar used in construction helps determine the possibility of reusing bricks. Cement mortar poses challenges in this regard whereas lime mortar offers convenience for recovering and reutilizing bricks. Nevertheless, if certain mechanical requirements are satisfied, recycled brick powder can be employed as a substitute for cement in mortar (Balasopoulou *et al.*, 2017).

Figure 2.7 illustrates waste from bricks.

Figure 2.7: Clay bricks waste ready for reuse (Zhu and Zhu, 2020)

2.4.3 Excavated soil

Excavated soil from construction sites has many uses such as filling in bare patches, landscaping and selling to horticulturists (Ozores-hampton and Biala, 2022). Contractors can save money on disposal costs, reduce landfilling by reusing excavated soil on site or in projects (Hale et al., 2021). Additionally, by combining excavated soil with waste it is possible to produce topsoil (Hale et al., 2021).

2.4.4 Steel

Steel reinforcement bars from concrete waste can be recovered, remolded, and resold, leading to energy savings and reduced CO_2 emissions (Liz and Luis, 2022). Recycling and reusing steel bars offer cost savings and environmental advantages (Ness *et al.*, 2015; Kok *et al.*, 2017). Furthermore, recycled steel girders can be utilized in constructing the building framework. In addition to steel reinforcement bars, metal waste types like scrap beams, corrugated iron sheets (zinc) nails, metal trimmings from roofing installations, binding wires, etc. can also be reused (Amadi and Chijioke, 2018). When repurposed effectively through recycling practices scrap metal finds application in building facades.

A durable and resilient outer shell will be constructed by utilizing a blend of reinforced panels and steel frameworks (Merli et al., 2020). Figure 2.8 represents stainless steel waste salvaged from demolished buildings.

Figure 2.8: Stainless Steel waste from demolition site for reuse. Unified Alloys, 2024 (https://www.unifiedalloys.com/blog/recycling-stainless-steel)

2.4.5 Wood

Wood waste can be effectively repurposed, recycled or used for bioenergy (Bais Moleman et al., 2018). Reclaimed wood can be reused in temporary construction projects such as formwork, scaffolding and earthwork supports (Amadi and Chijioke, 2018). Moreover, wood waste can be transformed into filler material, plasterboards, mulch for landscaping purposes, animal bedding, composting material, and pathways (Amadi and Chijioke, 2018). Figure 2.9 displays an example of landscape mulch.

Furthermore, utilizing wood fiber insulation as a construction strategy is gaining recognition. Recycled wood chips are employed to produce the insulation made from wood fibers. By utilizing more recovered wood fiber, the insulation can reach its highest grade (of reduced environmental effect) (Turku *et al.*, 2017). When used for insulation purposes, buildings are clad and weatherproofed. Recycled wood chip-based wood fiber insulation contributes to sustainable construction practices and energy efficiency (Bais Moleman et al., 2018).

Figure 2.9: Wood waste reused as Landscape mulch. Double A Lawn scaping & Supply (https://www.doublealawnscapingandsupply.com/landscape-groundcover.html.)

Figure 2.10 shows a typical wood fiber insulating material.

Figure 2.10: Wood fibers used for insulation in buildings (Kretzer, 2002).

2.4.6 Global examples - Summary

Various examples across the globe are presented in Section 1.4.5 to showcase approaches in managing waste sustainably by reusing and recycling CDW.

To minimize waste production and enjoy benefits such as higher quality and quicker construction, precast and prefabricated structures can be constructed using concrete, which constitutes a portion of CDW. While there have been instances of using recycled waste concrete as an alternative to aggregate for road repairs, challenges still exist. Notably recycled concrete aggregate (RCA) has shown results in concrete projects.

Another common component of CDW is brick, which has been creatively repurposed for purposes like facades and substrates for roofs. The ease of recovering and reusing bricks depends on the type of mortar used during construction. Recovering cement mortar is more challenging compared to lime mortar; however, by meeting requirements recycled brick powder can partially replace cement in mortar.

Excavated soil from construction sites finds uses such as landscaping filling holes or uneven surfaces and selling to horticulturists. Contractors can effectively reduce landfilling. Avoid disposal costs by recycling excavated soil on site or, in projects. When combined with waste excavated soil can yield topsoil that adds value to the reuse process.

Recycling, repurposing, and reselling steel reinforcement bars extracted from debris can play a role in conserving energy and reducing CO2 emissions. The positive impact on the environment and cost reduction are among the benefits of recycling and reusing steel bars. Various types of scrap metal, such as beams, corrugated iron sheets, nails and binding wires can be recycled to create durable building facades.

Wood waste offers lucrative options for its reuse, repurposing, recycling, or bioenergy utilization. Reclaimed wood is commonly used in constructing earthwork supports, formworks and scaffolding. Furthermore, wood waste can be transformed into filler material for construction purposes. Utilized in making plasterboard or mulch for gardening. It can also serve as bedding for animals. Contribute to composting efforts. Green building techniques are gaining popularity due to the advantages offered by wood fiber insulation made from wood chips – aiding both construction practices and energy efficiency goals. This type of insulation meets environmental impact standards by utilizing quantities of reclaimed wood fibers. By minimizing waste generation and maximizing resource efficiency in line with these standards for CDW reuse and recycling practices worldwide; the construction industry has the potential to achieve sustainability.

2.5 Management of CDW in Developing Countries

Developing and developed nations employ different techniques for CDW management. Industrialized countries (like Germany) employ cutting-edge management strategies like mobile sorting, increased resolution, etc, that have been shown to support CDW reuse and recycling (Srivastava, 2016). In support to this, (Lauritzen (2018) revealed that several countries have banned the disposal of CDW, except for recyclable waste managed by demolition companies. However low-income nations face challenges in handling CDW due to resources, inadequate infrastructure, and insufficient waste management systems. Consequently, a considerable amount of CDW ends up in landfills causing harm and posing health risks (Menegaki and Damigos, 2018a; Kabirifar *et al.*, 2020; Oliveira, de Oliveira and Fonseca, 2021).

In developing countries uncontrolled dumping is currently the prevailing practice (Naibbi and Umar, 2017). Embracing circular economy principles offers an approach for managing CDW in developing nations. Encouraging the reuse and recycling of CDW materials can help reduce waste generation and conserve resources (Hobbs and Adams 2017; Ramos et al. 2023). Moreover, integrating circular economy concepts into CDW management can create business opportunities like recycling ventures and innovative building materials development (Huang et al., 2018).

Moreover, several developing countries are currently exploring the effectiveness of public private partnerships (PPPs), in the management of CDW. By combining the resources and expertise of the sector with the power of the government, PPPs can offer a more reliable and sustainable framework for waste management (Spoann *et al.*, 2019). However, it is crucial for both local governments and international organizations to raise awareness support policies and make investments to successfully implement these initiatives (Spoann *et al.*, 2019). For privileged nations to adopt CDW management practices it is imperative to focus on capacity building and provide technical support (UNEP, 2018).

2.5.1 Informal Waste Collection in Ghana, South Africa, and Botswana

This section will delve into the significance, challenges, and contributions of waste collection methods in Ghana, South Africa and Botswana towards CDW recycling and resource recovery.

Many Asian countries as nations in America and Africa have heavily relied on informal waste collection methods, for managing CDW. These countries have embraced this approach to handling CDW. Informal waste workers gather materials while recovering resources from streets and neighborhoods as part of their efforts to promote recycling operations related to CDW. However, there are challenges associated with this system, such as a lack of support and recognition leading to the often-unnoticed efforts of waste collectors. Nonetheless, these grassroots initiatives impact waste reduction and protecting the environment. It would be beneficial to acknowledge and promote these heroes as it can contribute to sustainable garbage management in these areas.

Moreover, waste pickers play a role in extracting materials from piles in rapidly growing Asian cities like Mumbai and Jakarta. These cities have networks for waste collection (Hicks, 2023). Similarly in Latin America recyclers known as "recicladores" actively contribute to the recycling of CDW (Hoang *et al.*, 2020). Despite their resource recovery efforts challenges such as working conditions and lack of government recognition persist. Embracing the disorderliness of waste collection can lead to significant advancements in global waste management.

<u>Ghana</u>

In Ghana, waste collectors, formally known as "kayayei" or "agbogbloshie " are seen in metropolitan areas (Balasopoulou *et al.*, 2017; da Silva, Weins and Potinkara, 2019). Primarily comprised of women and young girls they gather types of waste including CDW from households, construction sites and informal settlements.

They play a role in preventing waste from ending up in landfills and making recycling and reuse more accessible (de Silva, Weins and Potinkara, 2019). In Ghana informal waste workers face challenges. They put their health and safety at risk by working in conditions without protective gear or waste collection tools (Hartmann, Hegel and Boampong 2022).

The lack of regulation and integration into the waste management system is due to the governments recognition and support for formal waste management systems (Olukanni and Nwafor 2019). Despite these challenges informal waste workers in Ghana make contributions to CDW recycling. They sort the collected debris into categories. Sell recyclable materials to recycling businesses or reuse items like wood, metal and concrete. For example, salvaged wood can be used as construction materials or furniture while scrap metal can be sold for recycling.

<u>South Africa</u>

South Africa also heavily relies on informal waste workers, also known as "skarrelers” for CDW management. These individuals gather garbage including CDW in low-income and informal settlements, with the aim of recycling it for revenue generation.

To strengthen their bargaining power and gain market access, they frequently create cooperative organizations (Bhakta *et al.*, 2020; Yu, Blaauw and Schenck, 2020; Viljoen *et al.*, 2021). Similar challenges are encountered by waste workers in Ghana and South Africa. They operate in environments with less infrastructure and safety measures. Additionally, prejudice and discrimination hinder their integration into formal waste management systems (Gunsilius et al. 2011; Murphy, 2012; Ebenso et al., 2019).

Despite these obstacles South African informal waste workers play a role in recycling CDW. They recover building materials such as metal, concrete and bricks from construction sites. These materials are utilized for other projects or sold to recycling businesses. Like other developing countries, the sorting of recyclables is primarily carried out by the informal sector rather than the official/formal recycling sector. The sorted recyclables are often bought by buyers or scrap yards sometimes engaging in bartering (Bhakta et al., 2020). Particularly in vulnerable communities, their actions contribute to waste diversion efforts, resource recovery and job creation.

Botswana

The informal waste collection industry is also thriving in Botswana where individuals involved are referred to as "scavengers" or "recyclers."

These individuals gather different types of waste such, as construction and household waste from areas, construction sites and landfills (Phonchi-Tshekiso, Mmopelwa and Chanda, 2020). Their primary objective is to sort and collect materials that can be sold to the recycling industry.

In Botswana, issues faced by informal waste workers include lack of training in suitable waste management techniques, restricted access to waste collection gear, and inadequate support from formal waste management systems (Fadaei, 2022). The lack of adequate infrastructure and facilities for waste sorting and storage made their operations more difficult (Fadaei, 2022). Despite these problems, Botswana's informal waste collectors play an important role in CDW recycling. They rescue resources in great demand for construction projects, such as metal, concrete blocks, and bricks.

2.5.2 Managing CDW in developing countries - Summary.

Informal waste collectors play a role in countries like Ghana, South Africa and Botswana by helping to reduce waste, conserve resources and promote sustainability (Mmereki, Daniel;

Velempini, Kgosietsile; Mosime-Serero, 2021). While these countries have similarities in their strategies for managing construction and demolition waste (CDW) they also face challenges.

In these nations informal waste collection is essential for managing CDW. Despite the difficulties faced by waste collectors in these countries, their efforts impact recycling CDW and recovering valuable resources. They contribute to sustainability, job creation and diverting waste from landfills. By recognizing and supporting the waste collection sector in Ghana, South Africa and Botswana improved CDW management techniques can be implemented to achieve economic and environmental goals.

Managing CDW in developing countries presents challenges that require specialized solutions. While developed nations have adopted methods, for CDW management developing countries need to focus on community-based initiatives, private partnerships, and principles of circular economy to effectively address this growing environmental concern. To enhance the management of CDW in Nigeria it would be advantageous to examine the experiences of waste workers, in Ghana, South Africa and Botswana. Firstly, it is crucial to acknowledge the role played by waste workers and include them within formal waste management frameworks. By providing them with support and resources such as waste collection tools and safety equipment we can improve their working conditions and overall wellbeing. Secondly raising awareness about waste workers and reducing stigma against them can facilitate their integration and collaboration with established waste management systems. This approach will encourage Nigeria to adopt an inclusive strategy for managing waste. By learning from the experiences of these countries Nigeria can enhance its CDW recycling efforts empower its waste collectors and establish an inclusive and efficient waste management system.

2.5.3 Activities of Informal Waste Workers in Africa

In Africa informal waste workers play a role in managing waste and transforming it into valuable resources. These dedicated individuals contribute significantly to recovering waste without receiving any assistance from the government. Studies conducted by Nyathi et al. (2018) and Ferronato et al. (2019) have highlighted that they outperform the formal sector in terms of recovery rates.

However, waste pickers/scavengers have a different perspective compared to authorized/formal system. Their primary focus is not on reducing health risks but on reclaiming valuable items that support their livelihoods (Nyathi, Olowoyo and Oludare, 2018). Scavengers engage in activities such as collecting waste from dumps or going door to door for recycling purposes (Rutkowski and Rutkowski, 2015). Waste pickers on the other hand gather materials from homes, markets, streets and trash cans (Abenu *et al.*, 2022; Isomah, Chuku and Harcourt, 2022).

Despite their marginalized economic status (Boateng, 2017), informal waste workers make contributions to both the economy and the environment. They help reduce garbage accumulation while providing materials for the recycling industry. Moreover, their involvement saves council funds that would otherwise be spent on waste transportation and disposal (Boateng, 2017).

2.5.4 Key Actors in African Waste Management - Issues of power and difference

It is crucial to identify the actors and understand their roles within the structure to establish a waste management system in Africa. This could be done by structuring this section with key actor groups (policy stakeholders, construction stakeholders and informal waste workers). However, it is important to note that most literature was not specific to each actor. This, however, limits previous literature regarding waste management actors in developing countries.

The complexity of waste management in Africa arises from the involvement of various key actors, each playing different roles (Akintayo *et al.*, 2023). The power dynamics among these actors significantly influence the efficiency and effectiveness of waste management in Africa. To establish an effective waste management system, it is essential to identify these actors and understand their roles within the structure. The following sections will elaborate on the roles and issues associated with three main key actor groups (Construction, policy makers and Informal Waste workers), using South Africa, Kenya, Ghana, Botswana, and Nigeria as key examples.

There is nearly unanimity of opinion from available literature that waste governance in most developing countries, particularly Sub-Saharan Africa, is nearly at a crisis (Nzeadibe, 2013; Myers, 2017; Ezra & Roberts, 2014; Kaza et al., 2018; Ndam et al., 2023). Compared with significant improvement in performance indicators in developed countries such as Western Europe, the situation in Africa becomes even more glaring.

2.5.4.1 Policy Key actors: (State and Local Governments)

State and local governments are pivotal in shaping the regulatory framework for waste management in developing countries. They are responsible for formulating policies, enforcing regulations, and providing infrastructure for waste collection, transportation, and disposal.

For example, in South Africa, the National Environmental Management: Waste Act (2008) mandates local governments to develop integrated waste management plans (IWMPs) (Manamela, 2022). However, the implementation often faces challenges such as inadequate funding, lack of technical expertise, and corruption (Todes and Turok, 2018).

In Kenya, the National Environment Management Authority (NEMA) oversees waste management regulations but struggles with enforcement due to limited resources. Despite having approximately 77 statutes relating to environmental concerns, Gikaria, (2020) argues that the failure of the laws and regulations for waste management in Kenya to address governance-related problems is largely due to a systemic inability and or an unwillingness on the part of state actors to sanction or deal with those who flout such laws. Also, corruption and limited resources hinder effective implementation, exacerbating inequalities in service provision.

The key actor in Ghana's waste management is the Ganian Ministry of Sanitation and Water Resources, which formulates policies and regulations (Ntow., 2019). Moreover, the Environmental Protection Agency (EPA) oversees environmental issues, including waste management regulations (Asibey, 2021). However, challenges persist, including inadequate infrastructure, insufficient funding, and limited public awareness (Godfrey et al., 2019). Efforts are ongoing to improve waste management systems through policy reforms, infrastructure development, and community engagement initiatives (Asibey, 2021).

In Botswana, Government agencies play a significant role in policymaking, regulation, and enforcement of waste management laws (Mmereki et al.,2021). Local authorities are responsible for waste collection, disposal, and ensuring compliance with regulations at the community level (Mmereki et al.,2018). Waste management companies are often contracted by the government or local authorities to provide services such as collection, recycling, and disposal of waste. Communities are essential stakeholders in waste management as they generate waste and are directly impacted by its management (Mmereki et al.,2018). Marginalized communities, such as informal settlements or rural villages, may face greater challenges in accessing adequate waste services and suffer disproportionately from the negative impacts of poor waste management practices (Mosha et al., 2022).

In Nigeria, for example, government agencies and regulatory bodies are responsible for developing waste management policies, rules and regulations (Ogunkan, 2023). They closely monitor waste management operations to ensure compliance with regulations (Ogunkan, 2023). Examples of these entities include the National Environmental Standards and Regulations Enforcement Agency (NESREA), State Environmental Protection Agencies (SEPAs), and the Federal Ministry of the Environment as their state counterparts. At the local level, local government bodies have a role in waste management. Within their jurisdictions they oversee waste collection, transportation, and disposal activities (Akintayo et al., 2023). In essence, recent reforms in waste governance infrastructure at the federal and state levels in Nigeria were not reciprocated at the local or municipal level. This situation has tended to exacerbate waste governance outcomes at the local or city level.

To ensure waste management practices the municipals may also collaborate with waste management companies. The private sector is increasingly contributing to Nigeria’s waste management efforts by offering services such as waste collection, recycling and disposal for businesses, residential areas and industries (Akintayo et al., 2023). However, challenges related to power dynamics and different bodies pose obstacles to CDW management in Nigeria.

Biyani & Anantharaman (2017) refers generically to “policy makers” as key stakeholders when considering the issue in Nigeria’s waste management which include the recruitment strategy which often relies on family connections, as such, creating obstacles for waste management. This is because persons recruited may not have the technical capability to successfully carry out the waste management. Additionally, it has been observed that various stakeholders involved in waste management in Nigeria have goals and motivations that differ from the government's vision. Some may prioritize gains above achieving government objectives.

The cultural, political, and social dynamics between those who recruit others into the field of waste management should also be considered. One of the challenges regarding waste management in Nigeria is inadequate financial support provided to local government entities responsible for implementing waste management regulations effectively (Nivedita Biyani and Manisha Anantharaman, 2017). Furthermore, policymakers lack the tools to monitor and ensure compliance with these regulations by government actors (Nivedita Biyani and Manisha Anantharaman, 2017). These problems continue to threaten waste governance in most urban areas and call into question the capacity of Nigeria to provide effective waste governance for her cities. The situation is not much different in some Asian countries either; for instance, Bhuiyan (2010), reported that in Bangladesh, despite increasing utilization of public resources, city governments have apparently failed to provide satisfactory conservancy services to residents. However, Moore (2001) argues that 'bad governance' is neither inherent in the culture or traditions of the people of poor countries nor a product of poverty. It is rather the result of the ways in which state authority in the developing countries has been constructed and is being maintained through economic and political interactions with the rest of the world. He further points out that the policies and practices of developed countries' governments and the pattern of international economic transactions help sustain poor governance in developing countries (Moore, 2021).

In each of these countries, addressing power differentials and promoting inclusive decision-making are critical for advancing sustainable waste management practices and achieving environmental justice. This requires collaboration among key actors, transparency in policy making processes, and recognition of the diverse needs and perspectives of affected communities.

2.5.4.2 Construction Key actors

Key actors within the construction sector include small to medium-sized enterprises (SMEs), private contractors, and construction companies.

For instance, in South Africa, SMEs are instrumental in the operation of material recovery facilities (MRFs) that separate and process recyclable materials from construction sites (Manamela, 2022). They contribute to the circular economy by converting waste into reusable materials, thereby reducing the demand for raw materials and minimizing environmental impact. Private contractors are increasingly becoming key players in waste management, particularly in urban areas where municipal services may be inadequate. They are often contracted to handle waste collection, transportation, and disposal for construction projects.

In Nigeria, for example, Private contractors are increasingly involved in waste collection and disposal services, filling the gaps left by inefficient municipal services (Ogunkan, 2023). Companies like LAWMA (Lagos Waste Management Authority) partner with private firms to enhance waste collection efficiency (Akintayo et al., 2023). Yet, issues such as inconsistent service quality, lack of accountability, and limited coverage persist. In Nigeria, Construction companies generate significant amounts of waste, and their role in waste management includes ensuring proper disposal of construction debris (Akintayo et al., 2023).

In Kenya, regulations require construction firms to adhere to waste management protocols, but enforcement is weak, leading to improper disposal practices. The lack of stringent regulations and monitoring exacerbates the problem of construction waste.

Construction key actors face challenges such as compliance and enforcement, cost implications and coordination Ike et al., 2018. To address these challenges, collaborative efforts and best practices can be adopted. This includes public private partnerships, regulatory reforms, capacity building and awareness and education and integrated waste management (Olukanni and Nwafor 2019).

Construction

2.5.4.3 Informal waste workers

Informal waste workers, including waste pickers and recyclers, are crucial yet often overlooked actors in the waste management system. In Ghana, informal waste pickers play a significant role in recycling, collecting recyclables from landfills and households. Despite their contributions, they face hazardous working conditions, lack of social protection, and minimal recognition from formal systems South Africa has a well-established informal waste sector, but workers face challenges such as lack of recognition, low wages, and exposure to health risks. Efforts to formalize this sector have been met with mixed success, reflecting power struggles between informal workers and formal institutions (Morais *et al.*, 2022). Informal waste pickers are prevalent in Kenya's urban areas, providing valuable recycling services but facing marginalization and exploitation (Zapata Campos, 2023). Efforts to integrate them into formal waste management systems face resistance from vested interests and bureaucratic hurdles.

In conclusion, Policy key actors have considerable influence over regulations and funding, yet often face challenges in implementation due to corruption, inadequate resources, and political instability. Construction key actors, particularly SMEs, have the potential to drive innovation and job creation but are hindered by regulatory and financial constraints. Informal waste workers, despite their essential role, remain marginalized, with limited access to resources and social protection. The disparity in power and resources among these groups leads to fragmented efforts and suboptimal outcomes in waste management. Collaborative approaches that integrate the efforts of all stakeholders, supported by strong regulatory frameworks and adequate funding, are essential for sustainable waste management in Africa.

2.5.5 Barriers to CDW Reuse and Recycling in Africa

The reuse of CDW in developing nations faces societal economic obstacles. A significant hurdle is the reluctance of specifiers to incorporate CDW as materials (Silva, de Brito and Dhir, 2017b; Li, Han and Lu, 2018). The insufficient utilization of these resources stems from a lack of understanding and awareness regarding CDW management requirements (Mudashiru et al., 2016; Ike et al., 2018). This disparity between developing countries and their developed counterparts can be attributed to differences in construction practices, standards, weak legislation, inadequate governance systems and inadequate oversight over construction activities (Olukanni and Nwafor 2019). The improper enforcement of waste legislation results in dumping of waste in landfills (Olukoju, 2018).

As mentioned earlier in Section 2.2.5 improper disposal methods have impacts on society in terms of political and economic aspects since they contribute to environmental pollution and pose risks to public health and safety (Chisholm et al., 2021).

2.5.5.1 Legal Barriers

Regarding barriers in CDW management many developing countries, such as Nigeria face challenges in enforcing related laws. Legal obstacles exist in nations like Cyprus, India, the Czech Republic, and Malaysia (Duan et al., 2015; Zhang et al., 2020). The situation worsens due to the lack of regulations governing CDW management in developing nations. Construction stakeholders such as developers, contractors, consultants, and clients often overlook the importance of CDW management (Caldera et al., 2020). They tend to classify CDW as part of waste (Olukanni and Nwafor 2019). Moreover, the limited inclusion of systems in the curricula of developing nations hampers the adoption of knowledge in construction methods (Hossain et al., 2020; Islam et al., 2021). The gap between policy formulation and practical implementation further hinders progress, in CDW management (Alite et al., 2023).

2.5.5.2 Barriers relating to Resources to manage CDW

Managing CDW effectively poses challenges in disadvantaged countries due to limited technology and financial resources. Inadequate storage facilities and collection services hinder the management of CDW leading to its disposal in open areas. To ensure CDW management it is crucial to foster cooperation while sustainability requires increased interest and participation from both the public and decision makers. The financial aspects of CDW management continue to be a topic of debate in both developing nations. Notably the composition of CDW in developing countries differs significantly from that of developed nations with a majority consisting of waste materials such as dust, sand and stones.

2.6 Review of Construction Waste Types and Disposal Practices Existing in Nigeria

2.6.1 Amount of CDW and effect

The generation of amounts of CDW by the Nigerian construction sector contributes significantly to sanitation issues in urban areas and suburbs within the country. However, there is unreported data, on the volume of CDW produced in Nigeria.

However, the amount and makeup of CDW produced vary across states and between rural areas every year (Zhang et al., 2020). For example, due to a surge in construction projects it is projected that Abuja will generate 3,000 tonnes of solid waste daily (Salami et al., 2019). According to the Lagos Bureau of Statistics the Lagos metropolis generates an average of 1.2 kg of waste per person per day (per capita generation). Around 20,000 MT of waste per day (Tongo, 2023).

Moreover, then Nigerian construction sector consists mainly of small and medium-sized native companies and makes a sizeable contribution to the GDP of the nation's economy (Saka and Adegbembo, 2022). Businesses are categorized as medium sized based on their revenue and capital levels (Ogunsanya et al., 2022). Some major construction firms are also overseen by entities (Ogunsanya et al., 2022). It is important to note that these businesses in Nigeria operate independently than being government owned or controlled (Ogunsanya et al., 2022).

As time progresses, the Nigerian construction activities have experienced growth leading to an increase in CDW production, at various stages of projects.

Despite the construction industry, in Nigeria being a generator of waste it has shown reluctance in adopting friendly practices (Olanrewaju and Ogunmakinde 2020; Ogunsanya et al., 2022). In Nigeria the improper disposal of CDW has effects on both the environment and public health. For example, excavated materials are often dumped in areas such as water bodies leading to pollution and harming water resources (Ike et al., 2018). Leftover bricks and concrete from construction projects are frequently abandoned in spaces. Left at construction sites (Aigbavboa, Thwala and Aghimien 2023). This not only leads to drainage systems but also contributes to land degradation during the rainy season (Aigbavboa, Thwala and Aghimien 2023).

Improper disposal of plastic bags and containers is another form of packaging waste that causes pollution and obstructs drains. Demolition waste is often dumped near areas. Left at demolition sites resulting in unsightly surroundings with potential hazards. Mishandling waste like paint, solvents and chemicals can contaminate land and water sources while posing health risks, for workers and local communities (Ferronato and Torretta 2019).

In Nigeria the construction industry heavily depends on materials that are imported. This reliance could be due to the preferences of clients. For instance, according to Danias research in 2016 a significant amount of imported CDW materials are used for finishing touches like tiles, paints, furniture and gypsum. These materials are commonly found as waste on construction sites.

Figure 2.11 illustrates CDW disposal in unauthorized places.

Figure 2.11: Heaps of construction waste disposed in unauthorized place. GoCodes, 2024 (https://gocodes.com/construction-waste-disposal/)

The waste disposal methods seen in Nigeria highlight the poor infrastructure for managing waste, the lack of enforcement of waste regulations and the limited awareness of waste management practices (Ike et al., 2018). To mitigate the impact on the environment and public health caused by waste disposal, Nigeria needs to address these issues and adopt more efficient approaches to handle construction waste.

According to a study conducted by Akani (2007) in Ilorin, southwest Nigeria as cited by (John and Itodo, 2013) material waste had a role in 146 construction projects. The main contributing factors were identified as "site storage " "transportation and delivery " and "theft." However, it is important to note that these findings are based on perceptions than measurements of waste, from a specific source. Figure 2.12 illustrates these findings.

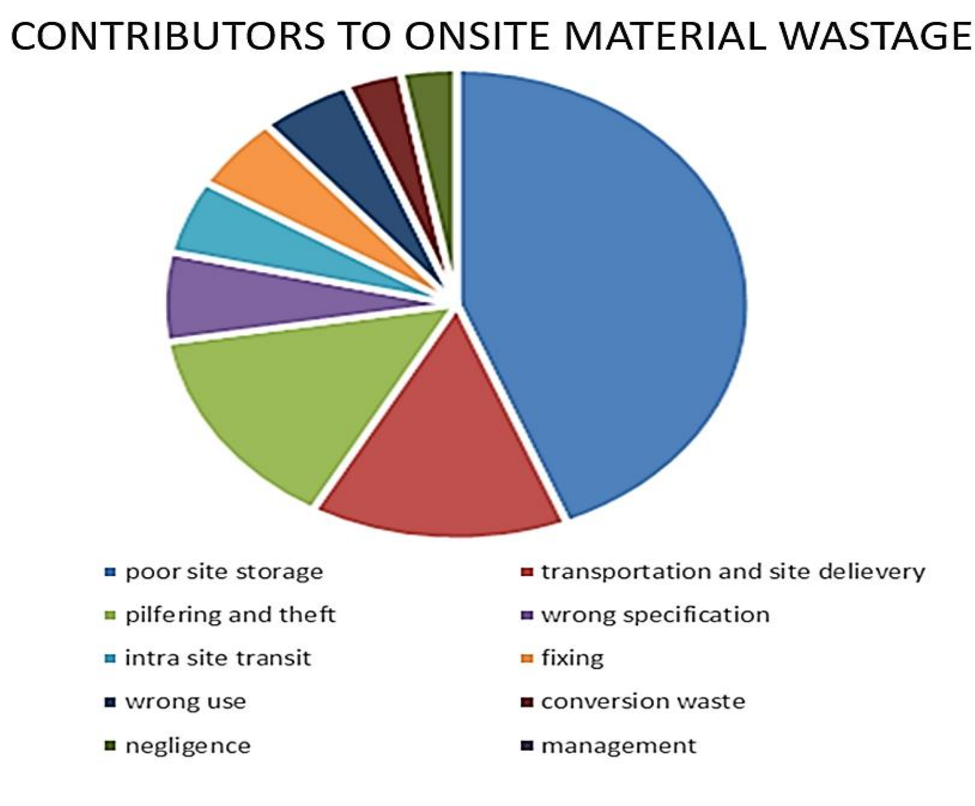

Figure 2.12 Contributors to onsite material wastage (adapted from Akani, 2007).

CDW management practices in Nigeria are inefficient and predominantly informal as noted by Ferronato and Torretta (2019). The prevalent approach involves both illegal dumping of waste in authorized and unauthorized landfill sites with some private companies profiting from waste collection (Villoria Sáez and Osmani 2019; Amadi and Chijioke, 2018). Additionally, it is common to dispose of waste near roadsides or open spaces (Ezechi et al., 2017). Unfortunately, the Nigerian government has not made efforts to promote CDW reuse. Instead, this responsibility falls upon contractors and clients who earn money by selling waste materials (Amadi and Chijioke, 2018). Consequently, CDW often gets mixed with other types of solid waste in disposal facilities (Amadi and Chijioke, 2018).

Several factors contribute to the challenges faced in reusing and recycling CDW within the context. The rapid urbanization and infrastructural expansion experienced by the country make managing CDW extremely difficult. Building activities generate an amount of waste that requires waste management strategies due to inadequate infrastructure for waste disposal along with limited landfill space availability (Kaluarachchi, 2018). Moreover, Nigeria's commitment to the Paris Agreement on climate change as the Sustainable Development Goals (SDGs) set by the United Nations necessitate the implementation of sustainable practices, across various sectors including construction. Based on these international commitments the reuse and recycling of CDW can play a role, in Nigeria's journey towards achieving environmental sustainability, resource efficiency and climate resilience (Oyedele et al., 2018).

In summary, the reuse and recycling of CDW have political and economic implications. These activities hold the potential to improve the environment generate employment opportunities, skill development, support development goals and reduce costs within Nigeria. By embracing CDW reuse and recycling practices Nigeria can effectively tackle waste management challenges while promoting building techniques. Furthermore, this approach aligns with efforts to establish an economy and ensure long term environmental sustainability.

2.6.2 Management of construction and demolition waste (formal and informal)

2.6.2.1 Nigerian government requirement for formal management of CDW

Regarding waste management, the Nigerian government regulations have been in place since the colonial era (1901 - 1960) to safeguard the environment and promote welfare. This includes public health laws introduced in 1958 that specifically address waste management. However, Nigeria has faced obstacles in establishing a waste management system since gaining independence in 1960. Factors such as infrastructure, lack of governance mechanisms and financial constraints faced by local authorities have contributed to this challenge (Yusuf et al., 2016). One of the challenges faced in Nigeria is the absence of law enforcement to handle waste disposal. Another issue is the reliance on state funding for initiatives.

In Nigeria environmental concerns have been officially addressed by magistrate courts (Idem, 2017). Despite attempts efforts to create a clean environment have been unsuccessful. Initiatives like the "War Against Indiscipline" (WAI), market cleaning days and monthly sanitation days have not yielded desired results. The Ministry has also introduced bills such as the 2016 National Building Code, which're currently under review by the National Assembly (Oluborode, Zacchaeus and Sate 2017). Both before and after independence, the government’s focus on conservation primarily revolved around protecting natural resources with economic value (Olalekan et al., 2019). Municipal waste management in states falls under the responsibility of the Ministry of Health (Ogechukwu, 2020). Despite housing 15,000 companies, Nigeria lacks regulations governing hazardous waste or industrial pollution (Olalekan et al., 2019) leading to various challenges, for the country.

Lagos State stands out as the state with an established waste management strategy employing the Lagos State Waste Management Agency (LAWMA) to execute a waste management plan (Oluborode, Zacchaeus and State 2017). However, the implementation of legislation, in Nigeria has been hindered by a lack of commitment and various bureaucratic obstacles. An example of this can be seen in the environmental health law introduced in 2005 during the regime under Obasanjo's leadership (Angerbrandt and Themnér 2021). Nevertheless, not all states have fully embraced this approach. Many treatment plants constructed decades ago in Lagos, Ibadan, Jos and other major cities have become nonfunctional due to design and maintenance (Joseph et al., 2022). Environmental protection regulations are also designed to safeguard both health and environmental quality. The National Environmental Sanitation Policy for instance supports all laws related to development, housing, water supply, food security, disease control measures, flood and erosion management, drought control measures well as health services, in schools (Oluborode Zacchaeus and Sate,2017). In 1999, the government-initiated waste management projects across twenty-six cities nationwide. Private partnerships are being used in this initiative as mentioned (Oh and Hettiarachchi, 2020). The initiative includes;

- The establishment of new transfer loading stations to facilitate waste collection, transfer and recycling.
- The creation of briquette plants, in 26 cities by the Federal Ministry for recycling plastic waste.

- The implementation of the "Subsidy Reinvestment Empowerment" program (SURE P) which specifically focuses on waste management initiatives like waste management facilities, material recovery facilities and plastic recycling plants.
- Community based waste management programs aimed at promoting sustainability. The development of a facility for reclaiming and recycling scrap metal to manage metal waste and abandoned vehicles.

However, the process of implementing policies in Nigeria including policies can be challenging due to political interference (as highlighted by Yusuf et al. In 2016). Many states currently lack waste management policies. Rely on ad hoc committees comprised of resident contractors who may not possess the necessary technical expertise or equipment for proper waste collection and disposal (as noted by Oluborode et al. In 2017).

It has also been observed that public understanding and effective implementation of construction and demolition waste (CDW) management policies are still lacking. For instance, a significant majority of Nigerians (80%), lack awareness, about sustainability, are unaware of the consequences of improper waste disposal (Menegaki and Damigos 2018a). These findings clearly indicate the neglect towards CDW management in Nigeria. The overall aesthetics and public health of the nation are adversely impacted by this situation.

While CDW management issues may seem insignificant to lawmakers they will inevitably have long term repercussions. Apart from implementing policies, procedures and financial incentives, it is crucial to organize campaigns that raise awareness about environmental concerns and foster a sense of community participation to achieve waste management goals.

In Nigeria, pay as you throw (PAYT) waste management approach is referred to as use-based pricing. Under this system individuals who generate waste are held accountable for covering its disposal costs (Yusuf, Kamaruddeen and Bahaudin 2016). When waste producers bear responsibility for reducing their waste generation levels (Yusuf et al., 2016) it can be seen as a development. The level of support allocated to the CDW management sector can serve as an indicator of a government’s commitment towards this industry.

2.6.2.2 Informal approach to management of CDW in Nigeria

The management of CDW in Nigeria follows an approach - the common practice involves reusing CDW on site or selling it as scrap as highlighted by Rose and Stegemann (2018). The high demand for recyclables, levels of poverty and inadequate solid waste management all contribute to the activities of scavengers (Amadi and Chijioke, 2018). In Nigeria the primary building materials are concrete and wood with wood being particularly valuable due to its usage in firewood production and other heat generating industries. Construction and demolition sites recover these materials, which are then resold in markets that specialize in resale of used CDW (Amadi and Chijioke, 2018).

However, it is important to note that no official recycling process exists for CDW in Nigeria. Instead, waste pickers/scavengers hand select valuable items at construction sites, dumpsites or other places, before sorting them (Gutberlet, 2021; Hartmann, Hegel & Boampong 2022). Waste pickers play a role in waste management by removing 30% of the waste generated in cities (Chimereze, Omokhudu & Ahijo 2016; Nyathi et al., 2018). Despite their significance the exact population of scavengers remains unknown (Medina, 2001; Nyathi et al., 2018).

They face challenging working conditions and informal recycling practices that differ from CDW management methods using technologies (Pereira and Teixeira 2012; Nyathi, Olowoyo and Oludare 2018; Villoria Sáez and Osmani 2019).

Waste pickers possess a business sense – they understand which discarded materials can be sold for profit despite their lack of formal education (Amadi and Chijioke 2018; Morais et al., 2022). They are aware of markets where these products can be resold or used as materials by small-scale companies. When compared to Nigeria's minimum wage, informal recycling has shown to be a lucrative industry (Amadi and Chijioke, 2018; Abenu *et al.*, 2022). Therefore, considering the absence of alternatives, waste pickers should be recognized as an element of a comprehensive CDW management plan in Nigeria (Tongo, 2023). By acknowledging them and providing support scavengers working conditions could be improved while reducing health risks. Society would also become more accepting.

The Edun Market, located in Nigeria is a known marketplace where people can buy and sell recyclable and reusable materials, specifically CDW materials (Mudashiru et al. 2016). This market caters to customers including small scale contractors, individual buyers and farmers who need materials for constructing animal shelters. Additionally, traders who run shops and kiosks also rely on these materials to set up their businesses. These marketplaces can serve as models for managing CDW in parts of Nigeria.

In Nigeria the responsibility for managing CDW falls not on government officials but on clients and contractors (Tongo, 2023). However, due to the lack of requirements or contractual obligations, compliance from contractors is often partial. When public structures are demolished, the government does not recognize salvaged materials as resources. As a result, there is a paid service for removing CDW, where interested parties sometimes hire truck drivers to transport waste to locations (Amadi and Chijioke, 2018). Such practices are not allowed in developed countries that have adopted approaches for managing CDW (Ma, 2018). Moreover, many inexperienced small-scale contractors lack awareness of the benefits associated with CDW management. Unfortunately, improper waste management is quite common in many parts of Nigeria due to waste management practices prevalent, in the region.

The mixed waste is collected from dumpsites by authorized/formal waste collectors and contractors who then dispose it in burrow pits. Afterwards individuals known as scavengers sift through the trash to find items that can be recycled or reused. Despite earning money from this activity scavengers often face stigma making their jobs unappealing (Cruvinel et al., 2019). The handling of waste, in Nigeria exemplifies how different societies may have contrasting perceptions of what's considered trash versus valuable. This highlights the importance of a shift in mindset and the development of waste management plans in Nigeria.

2.6.3 How to improve CDW management in Nigeria.

To improve the management of CDW in Nigeria several steps can be taken. Firstly, it is crucial to raise awareness and provide education on this issue among stakeholders such as government agencies, contractors, and clients (Debnath et al., 2023). Secondly precise regulations and policies should be established for CDW management (Bains, Hongyi and Jialong, 2019). This would involve imposing penalties for dumping while promoting ethical practices in waste management (He, Yuan, and Wu 2022). Thirdly, the government should consider incorporating CDW management requirements into building contracts and ensuring compliance through inspections and monitoring (Blaisi, 2019).

Furthermore, investment should be made in infrastructure and facilities, for waste sorting, recycling and processing (Bertino et al., 2021). This involves constructing recycling facilities and CDW it is important for the government to encourage collaborations between businesses involved in waste management and construction firms. Additionally, supporting the establishment of recycling enterprises is Dawodu et al., 2022).

Moreover, it is crucial to recognize the role played by scavengers and other informal waste collectors and integrate them into the waste management system (Steuer et al., 2017). By providing them with training, safety equipment and improved working conditions we can assist scavengers. Regulating their activities while appreciating their contribution through support can result in more sustainable waste management practices (Bais Moleman et al., 2018).

2.6.4 Examples of CDW management in Nigeria

2.6.4.1 Reduction/avoidance

To reduce or avoid wastage as discussed in Section 2.3.1 design plays a crucial role. Unlike "designers and architects" who are not financially burdened by material costs it seems that some informal or private builders who purchase reused materials are inclined to be more cautious about minimizing wastage. Hence, it is important for private contractors, architects and designers, in Nigeria to understand that designing efficiently can help reduce waste.

Another aspect that Nigeria has overlooked is the reduction of waste generated on construction sites. By adopting sustainable material management practices, Nigeria can effectively minimize waste (Villoria Sáez and Osmani 2019). As designers and project managers are more concerned with cost control than waste control, material control is a new practice (Albert, Shakantu and

Ibrahim, 2021). However, implementing measures will not improve the quality of work but also enhance project profitability. The success of the project heavily relies on management of site activities (Egwunatum et al., 2022). Therefore, Nigerian construction managers should familiarize themselves with management techniques that promote waste minimization.

2.6.4.2 Informal Reuse and Recycling

Material reuse is a source of income for informal waste workers in Nigeria. When CDW is sorted, it becomes a marketable product that may be purchased and sold (Mudashiru *et al.*, 2016). They can be used again to make various home items or tools for work, such as cooking pots, stove, cutlasses, metal dustpans e.t.c (Huang *et al.*, 2018; Abenu *et al.*, 2022).

The recyclable CDW material (Aluminum waste) is depicted in Figure 2.13.

Figure 2.13 Aluminum roofing sheet waste remolded to cooking pots, bread molds: Work in progress (Abdullahi and Lee, 2018)

The informal waste workers hold the belief that only a small amount of goods end up in landfills as most of waste materials are repurposed and recycled. The concept of ecology involves producing goods using CDW, ensuring there is no waste in the system as it follows the principles of a circular economy. In this system one operations waste becomes the materials for another process. It is worth highlighting that informal waste materials reuse happens locally and privately.

Based on research conducted at six construction sites and two salvage marketplaces, it was observed that almost everything from building demolition sites is reused. For example.

- *Wooden door and window frames* sold for building stores, kiosks, and pig and chicken coops.
- *Waste wood:* utilized or recycled to create charcoal (for use in steam-producing plants), charcoal for roadside vendors to use to roast maize/corn, fresh fish, etc., and charcoal for cooking (in low-income earners' houses).
- *Louvers:* Although they are rarely used today, louvers are removed from the salvage market and resold at a lower price for the construction of new buildings.
- *Concrete:* crushed and screened for use as aggregate in road bases and as backfill materials.
- *Asphalt:* Crushed asphalt is recycled to make new tar, which is used as a road basis.
- *Site clearance:* Trees and bushes removed from the site are recycled and utilized as compost or mulch.
- *Metals:* These materials are melted (and reshaped) to create new metal goods. Metals that have been recycled have developed markets in Nigeria.

- *Concrete:* Many of the applications for which new concrete is utilized can also be accomplished with waste concrete. For some small contractors, recycled aggregate has recently been a source of income. For instance, research made in Uyo (capital of Akwa Ibom State, southeast Nigeria), shows about 100% use of RCA in concrete in construction (Ameh and Edike, 2014). Some of the contractors who advocate RCA continue to have concerns about its mechanical qualities. Unfortunately, ongoing resource extraction and the exploitation of virgin resources for building have not raised any issues in Nigeria. It is not yet widely accepted that future generations must practice resource conservation and environmental protection.

2.6.4.3 Waste disposal

Waste disposal is the final step in achieving waste management. According to a study, by Nasidi et al. (2018) one common approach is burying waste underground, which is practiced in many countries. Different nations employ landfilling techniques. In Nigeria landfills are often established in abandoned mines and excavation sites (Eze, Onwukeme, & Enyoh, 2022). However, the lack of designed and suitable landfills negatively impacts the environment. This becomes evident when trash gets blown around and scattered, causing pests infesting the area. The surroundings become unsightly.

Another method of waste disposal is incineration. In Nigeria, incineration and Waste to Energy (WTE) processes are primarily used for hospital waste due to the maintenance costs associated with incinerators (Ogwueleka, 2009; Moult *et al.*, 2018).

A Nigerian dump is depicted in Figure 2.14.

Figure 2.14: A CDW landfill in Nigeria Quatz, 2019 (https://qz.com/africa/1637931/lagos-entrepreneurs-champion-recycling-as-a-way-of-life)

2.7 Barriers/Drivers to Reuse and Recycling of CDW In Nigeria

In Nigeria, there are challenges that hinder the reuse and recycling of CDW. These include awareness among the population, inadequate infrastructure, financial limitations, and the absence of regulations for recycling. However, raising awareness about the benefits of managing CDW for both the economy and the environment along with implementing regulations and incentives can help to encourage reuse and recycling practices in Nigeria. Furthermore, by implementing waste management programs at construction sites in Nigeria we can achieve waste reduction goals (Mudashiru et al., 2016).

Another potential approach to boost recycling in Nigeria is to involve waste pickers/scavengers as a recycling method as suggested by Amadi and Chijioke (2018). This will have long-term benefits for both individuals and the economy.

The reuse and recycling of CDW can have political and economic impacts within Nigeria. From a perspective reusing and recycling CDW can help local communities create healthier environments. By diverting waste from landfills and reducing pollution levels we can improve air quality, soil health and water quality which will ultimately enhance living conditions for residents (Kaluarachchi, 2018).

2.8 Difference Between the Management of CDW in Developed Countries and Nigeria

The differences in managing CDW between developed countries and Nigeria can be attributed to the regulatory environments of these regions (Ezeudu and Ezeudu, 2019). While other developing nations face challenges, Nigeria encounters difficulties due to its limited institutional capacity, inadequate data and insufficient infrastructure (Ochieng and Odhiambo, 2019; Tongo, 2023). However, Nigeria does demonstrate potential in leveraging its waste management sector and implementing approaches to address CDW issues (Abdullahi and Lee 2018; Amadi and Chijioke, 2018). It's important to note that Nigeria's solid waste management challenges differ significantly from those faced by nations. Factors such as the quantity of waste generated, its density, composition, collection accessibility, economic and political context as attitudes and awareness among the population all contribute to these disparities (Nnaji, 2015).

Collecting waste in Nigeria presents challenges due to the inert nature (dust, stones, sand, etc.), and dampness (Lu, Yuan and Xue, 2021). For example, the city of Lagos alone is estimated to generate 255.556 tonnes of waste per month (equivalent to about 3.066672 tonnes, per year) (Abila and Kantola 2013; Abila,2018).

In Nigeria independent contractors often buy these CDW products to repurpose them on their construction sites or sell them to contractors or private clients. The common approach, in Nigeria is to reuse materials on site or sell them as scrap like using wood for firewood. This is mainly due to the use of concrete and wood in construction in Nigeria. A group of waste collectors known as scavengers, who are not officially recognized but play a role in the building sectors structure gather this waste.

Informal waste management, including the involvement of the sector plays a role in handling solid waste in many low- and middle-income countries like Nigeria (Kulkarni and Anantharama 2020). However, their contributions are not formally acknowledged by governments. There has been limited ethnographic research on waste management, such as studying the living conditions of waste pickers in Nigeria (Nzeadibe and Ajaero 2011).

While academic studies on waste management in Nigeria primarily focus on topics like impact and public health effects of garbage collection there has been no research yet on informal reuse practices specifically within Aba city. The informal waste sector in Aba shows potential for development. Exhibits locally adapted qualities that often contribute to innovations (Nzeadibe and Anyadike 2012).

The informal reuse and recycling industry, in Nigeria is experiencing growth. There is still much to discover about the daily lives and activities of waste workers in Aba. This study aims to shed light on a topic that has received attention providing insights into the reuse and recycling of CDW. The valuable contributions made by informal actors in managing construction waste in society. Additionally, it seeks to address the challenges faced by these actors in Nigeria while also exploring solutions for the future.

As previously mentioned, the informal waste economy comprises individuals, such as scrap dealers, scavengers, itinerant garbage collectors, intermediaries, informal recyclers and SMEs that rely on waste management for their source of income. The reuse of construction waste is particularly advantageous due to its viability compared to other types of waste. Scavenging is considered a survival strategy for 2% of populations residing in economically disadvantaged countries (Mbah and Nzeadibe 2017a).

2.9 Empirical Literature Review

Several empirical studies have been carried out across the globe to understand the practices, challenges, and factors influencing CDW management across different contexts:

For example, Kabirifar, Mojtahedi, and Wang, (2021) conducted a comprehensive overview of CDW management practices and challenges in Australia through a systematic review methodology. Analyzing 26 research documents and conducting in-depth interviews with construction industry experts, the study offers valuable insights into the current state of CDW management in Australia. The study identifies three significant factors affecting CDW management in Australia: stakeholder attitudes and behavior, CDW management in project life cycles, and regulations related to sustainability. However, the focus on Australia limits the generalizability of the findings to other contexts. Moreover, the reliance on expert opinions could introduce bias into the analysis.

Bin, Yuan and Ma, (2022) conducted an empirical study using the decision-making trial and evaluation laboratory (DEMATEL) approach to analyze key factors in CDW management. This quantitative analysis based on expert input provides insights into the interrelationships among various factors. The DEMATEL approach is a structured method that helps in understanding the complex causal relationships among factors in a system. The analysis reveals that government subsidies and waste-related trading systems are crucial factors, while investment by related enterprises is a passive factor in CDW management. However, the study is limited by the number and selection of experts, which could affect the representativeness of the results.

The empirical study done by Lacoboaea, Aldea and Petrescu (2019), explores CDW as a challenge for the European Union. The paper outlines each country's CDW generation, per capita CDW, CDW recovery rates, major obstacles to sustainable CDW management, and key drivers for sustainable CDW management. The authors conducted a literature review, interviews, surveys and data analysis to gather information on CDW generation, management practices, and policy frameworks in the EU. The study shows bias or limitations in the methodology used and limited focus on specific case studies or regions within the EU. Nations with dedicated CDW legislation tend to have higher recycling rates, suggesting their practices could be adopted by other European countries.

The study made by Daoud et al., (2021) addresses the challenge of CDW in Egypt, highlighting the lack of research on CDW generation, variations across different project types and factors affecting CDW reduction. Through structured interviews and comparative case studies, the research quantifies CDW generation rates and costs across industrial, residential, commercial, and infrastructure projects. Findings reveal differences in CDW generation among project types, influenced by project characteristics and applied CDW reduction factors like waste-efficient practices, awareness, culture & behavior, and legislation. The study identifies "timber," "sand," and "bricks/blocks" as the most wasteful materials on average, while "practices" and "legislation" emerge as the least applied CDW reduction factors across project types, indicating a need for better implementation for improved CDW reduction results.

The study conducted by Hoang et al., (2019) in Hanoi, Vietnam examined CDW at 15 sites. It found high waste generation rates ranging from 79.25 kg/m2 to 1,027 kg/m2 depending on site size and type. The study employed survey, interviews and composition analysis to explore major components of CDW including soil, concrete, and brick. The study projected an average annual CDW amount of 55 million tons from residential projects during 2012-2016, with a low recycling rate of about 10%. This highlights the urgent need for sustainable CDW management strategies, including standards for recycled products, supportive policies, and a viable business model for recycling, with future economic evaluations crucial for success

While previous empirical works on CDW management offer valuable insights, they exhibit various strengths and weaknesses in their methodologies, theoretical postures, and outcomes. Addressing these gaps can contribute to a more comprehensive understanding of CDW management practices in Nigeria, informing more effective waste management strategies. Further research is needed to explore the applicability of findings across different contexts and to incorporate advancements in technology and methodologies.

Table 2.1 is a tabular summary of the empirical studies, highlighting their methodological/theoretical postures and outcomes.

Table 2.1: Summary of Empirical studies

Study	Author	Year	Methodology	Findings and limitations
An Empirical Investigation of Generation Rate, Composition, And Handling Practices of CDW in Hanoi, Vietnam	Hoang et al., (2019)	2019	Survey, interviews, composition analysis	Limited to specific sites in Vietnam, may not fully represent CDW practices in other regions
Construction And Demolition Waste - A Challenge for the European Union?	Lacoboaea, Aldea and petrescu	2019	Survey, interview	Biase or limitations in the methodology used. Limited focus on specific case studies or regions within the EU.
Quantifying materials waste in the Egyptian construction industry: A critical analysis of rates and factors	Daoud et al., 2021	2021	Structured interviews and comparative case studies	Lack of research on generation, variations across project types, and factors affecting CDW reduction
Empirical analysis of key factors of CDW management using the DEMATEL approach	Bin, Yuan and Ma, (2022)	2022	Decision making trial & evaluation laboratory (DEMSTEL) approach	Government subsidies and waste related trading system identified as crucial factors in CDW management. Limitation: limited number and selection of experts may affect representativeness of results.

In summary, the empirical studies above offer valuable insights into CDW management across the globe.

In the developed countries, Australia, for example identified key factors affecting CDW management, including stakeholder attitudes, project life cycle integration, and regulatory frameworks. However, reliance on expert opinions may introduce bias. The European Union noted higher recycling rates in countries with dedicated CDW legislation. Policy frameworks and investment by related enterprises are key drivers for sustainable CDW management.

For the developing countries, Egypt, for example, highlighted variations in CDW generation across project types and factors affecting CDW reduction, such as waste-efficient practices and legislation. Vietnam revealed high CDW generation rates and low recycling rates, emphasizing the need for sustainable management strategies, supportive policies, and viable business models for recycling.

Points for consideration in Nigeria include conducting systematic reviews and empirical studies to understand the current state of CDW management practices and challenges in Nigeria, identifying key factors affecting CDW management, learning from best practices in other contexts, assessing the applicability of findings, and further research is needed to explore the specific challenges and opportunities for CDW management in Nigeria, incorporating advancements in technology and methodologies.

2.10 Framework of CDW ecosystems in both developed and developing countries

This section aims to produce a framework of CDW ecosystem in both developed and developing countries. The waste framework directive 2008/58/EC (WFD) (prevention, preparing for reuse, recycling, recovery and disposal) will be used as a basis for the comparison.

Table 2.2 Comparison of CDW management approaches based on Waste Hierarchy (Zhang et al., 2022)

Waste hierarchy stage	Developed countries	Developing countries
Prevention	Emphasis on waste prevention through regulations, incentives and voluntary agreements. Strategies include sustainable construction practices and construction waste management practices	Limited focus on waste prevention, due to factors such as rapid urbanization, lack of regulation, and resource constraints. N.b; some initiatives promote sustainable construction practices.
Reuse	Promote reuse through deconstruction, salvage and distribution networks. Growing markets for reclaimed materials and building components.	Common reuse of building materials driven by economic factors. Informal sector engage in salvaging and selling used materials.
Recycling	Well established recycling infrastructure for sorting and processing CDW materials such as concrete, asphalt, wood and metals. Materials are recycled to new products or used for road construction.	Limited formal recycling infrastructure, with informal recycling activities prevalent. Some materials like metals are recycled due economic incentives
Recovery	Utilize advanced technology for energy recovery from non-recyclable CDW, such as waste to energy plants, helps to reduce landfilling, and contribute to renewable energy production	Limited investment in waste to energy facilities. With most nonrecyclable CDW ending up in landfills. Informal waste pickers contribute to partial recovery
Disposal	Strict regulations on landfills. With landfill taxes and diversion targets, incentivizing alternative waste management options. Landfill used as last resort for residual waste.	Reliance on landfills for CDW disposal due to limited alternatives and waste management infrastructure. Landfills may lack proper environmental and engineering safeguards

Overall, developed countries tend to have more comprehensive CDW management approaches, with greater emphasis on waste prevention, recycling and recovery. However, developing countries face challenges such as limited infrastructure, resource constraints, resulting in less efficient CDW management systems and higher reliance on landfilling.

2.11 Chapter Summary

This study investigates the potential for reuse and recycling of CDW in Nigeria with specific focus on the role of informal waste workers in facilitating this. It highlights the importance of environmental sustainability, usually seen as a key driver of CDW management. The review explores examples of CDW reuse and recycling with a focus on materials such as steel, wood, concrete, brick and excavated soil (Section 2.4). This information provides insights that Nigeria can adapt to its context to implement best practices for material reuse and recycling.

The study further presents a comprehensive review of the management of CDW, with a particular focus on the disparities between developed and developing countries. Informal management of CDW in developing countries, such as Ghana, Kenya, South Africa and Botswana were reviewed. These countries were selected as being relevant to Nigeria's situation. This literature explored the actions of waste pickers and the contribution of the informal sector to CDW reuse and recycling (Section 2.6.4). The review also addressed the challenges and opportunities faced by developing nations. For example, informal sectors engage in salvaging and selling used materials, contributing to resource efficiency (Hoang et al., 2019). They, however, face challenges such as social stigmatization due to the nature of their work (Canpos et al., 2023).

With regards to Nigeria, the study critically assesses the state of CDW management in Nigeria and analyzes its impact on both the environment and local communities. The study also delves into Nigeria's framework for managing CDW as well as informal practices related to waste reduction, reuse, recycling and disposal. Alongside highlighting the necessity for sustainable solutions to achieve preservation of economic growth and social wellbeing within the construction industry. The study emphasized the need for collaboration among the various key stakeholders including policy makers, construction and informal waste workers to achieve CDW management. The study by (Akintayo *et al.*, 2023) particularly recognizes power dynamics and resource allocation disparities among stakeholders underscoring the significance of decision-making processes. Barriers to effective CDW management emerge as recurring themes in the literature, encompassing many challenges such as inadequate infrastructure, limited recycling facilities, fragmented regulatory frameworks, and socio-cultural barriers Amadi and Chijioke (2018). Lack of awareness, insufficient enforcement mechanisms, and economic disincentives further exacerbate the complexities associated with CDW management, hindering progress toward sustainable outcomes (Abdulahi &Lee, 2018).

Furthermore, empirical evidence underscores the importance of context-specific interventions tailored to the unique socio-economic, cultural, and environmental contexts of different regions. What works in one setting may not necessarily translate to success elsewhere, underscoring the need for localized solutions informed by rigorous research, stakeholder engagement, and adaptive governance mechanisms.

The collective insights gathered from previous empirical work on CDW management (Kabirifar, Mojtahedi, and Wang, (2021); Bin, Yuan and Ma, (2022)), yield a mosaic of outcomes and findings, ranging from barriers and challenges to success stories and innovative solutions. These outcomes serve as valuable waypoints in navigating the complex terrain of CDW management, informing policy decisions, industry practices, and academic discourse.

The literature recognizes the significant role of the informal sector in managing CDW in Nigeria and other developing countries like Ghana, Kenya, South Africa, and Botswana. Informal waste workers contribute to reuse and recycling operations by gathering materials and recovering resources from construction sites, streets and neighborhoods (Amadi and Chijioke, 2018).

However, the literature also acknowledges the challenges faced by this sector, including social, legal and financial barriers and the lack of support for these initiatives (Amadi and Chijioke, 2018). Major issues have been raised in the literature, including the disparities in CDW management practices between developed and developing countries, the role of the informal sector, and the challenges in enforcing related laws. The major issues identified in the literature can be grouped into political (the absence of regulations for recycling), social (awareness among the population), financial (financial limitations, and technical (inadequate infrastructure) (Abdulahi &Lee, 2018; Amadi and Chijioke, 2018).

Previous studies offer insights but exhibit strengths and weaknesses. Gaps exist in methodologies, theoretical postures, and outcomes. Previous studies have identified policy makers as the primary drivers in waste management initiatives (Abdulahi & Lee, 2018: Zhang et al., 2022). However, a further examination of the context in Nigeria, alongside a broader review of waste management literature suggests a significant, yet underrepresented role of informal waste workers (Amadi and Chijioke (2018): Spoann *et al.*, (2019): Abenu *et al.*, (2022).

Overall, literature findings on waste management in developed countries highlight the importance of strong policy framework and advanced technological solutions (Esa, Halog and Rigamonti, (2017); Huang *et al.*, (2018): Ezeudu and Ezeudu (2019): Zhang et al., (2022). They typically have well-established waste management systems that include comprehensive recycling programs, waste-to-energy technologies, and stringent regulations that promote sustainability and environmental protection. Key actors in these systems are often governmental agencies, private sector companies, and formal waste management services, all operating within a regulated framework to ensure efficient waste management practice. In contrast, literature findings on

developing countries emphasize the important role of informal actors as they often fill the gaps left by insufficient formal systems (Abdulahi &Lee, 2018; Amadi and Chijioke, 2018).
As a result, informal actors have become essential to maintaining waste management activities, despite operating in a largely unregulated and sometimes hazardous environment.

For Nigeria, the findings suggest a hybrid approach that leverages both formal and informal sectors by recognizing the informal waste workers and supporting them through training and regulation. This can improve efficiency and safety while acknowledging the vital role these actors play. Further literature findings also suggests developing and enforcing policies that support sustainable waste management practices, ensuring proper waste segregation and disposal, including collection systems, recycling facilities, and waste-to-energy plants, and implement programs to educate the public on the importance of waste reduction, segregation, and recycling to foster a culture of sustainability (Amadi and Chijioke (2018): Bertino et al., (2021): Debnath et al., (2023).
The literature findings underscore the complexity and contextual nature of waste management. While developed countries benefit from advanced technologies and robust regulatory frameworks, developing countries like Nigeria can harness the potential of informal actors to bridge systemic gaps. Recognizing and integrating the contributions of these informal actors, alongside strengthening formal systems, could lead to a more effective and sustainable waste management framework. This inclusive approach addresses waste management challenges and promotes social equity and economic opportunities for marginalized communities involved in informal waste activities.

Chapter 3 - RESEARCH METHODOLOGY

3.1 Chapter Overview

Among all the methods of data collection, the researcher employed literature reviews, surveys, interviews, and ethnographic (observation) methods for data collection. This is because they satisfy the research objectives well. However, given the constraints of the project especially given to travel restrictions due to the global pandemic, the researcher considered the digital method of data collection and observation by proxy. Moreover, thematic analysis was employed to analyze the data collected.

The research direction was set by addressing the research paradigm (axiological, ontological, and epistemological assumptions of the study) to identify an appropriate theoretical framework. This was followed by considering the suitability of the chosen research methods. Finally, the chapter included a detailed description of the chosen research methods and the theoretical framework for the research.

Two approaches to research methodology construction are.

- (1) - the research onion (figure 3.1) (Saunders, Lewis and Thornhill, 2019).
- (2) - the paradigmatic building block (figure 3.2) (Brown and Dueñas, 2020).

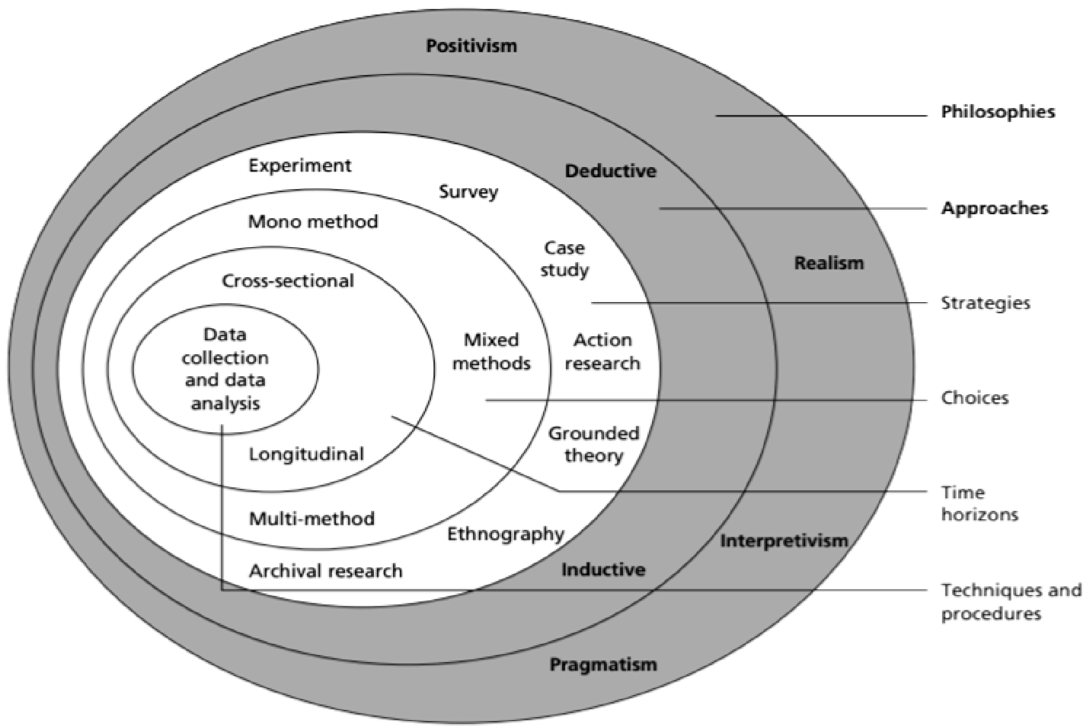

Figure.3.1 Research Onion ((Saunders, Lewis and Thornhill, 2019)

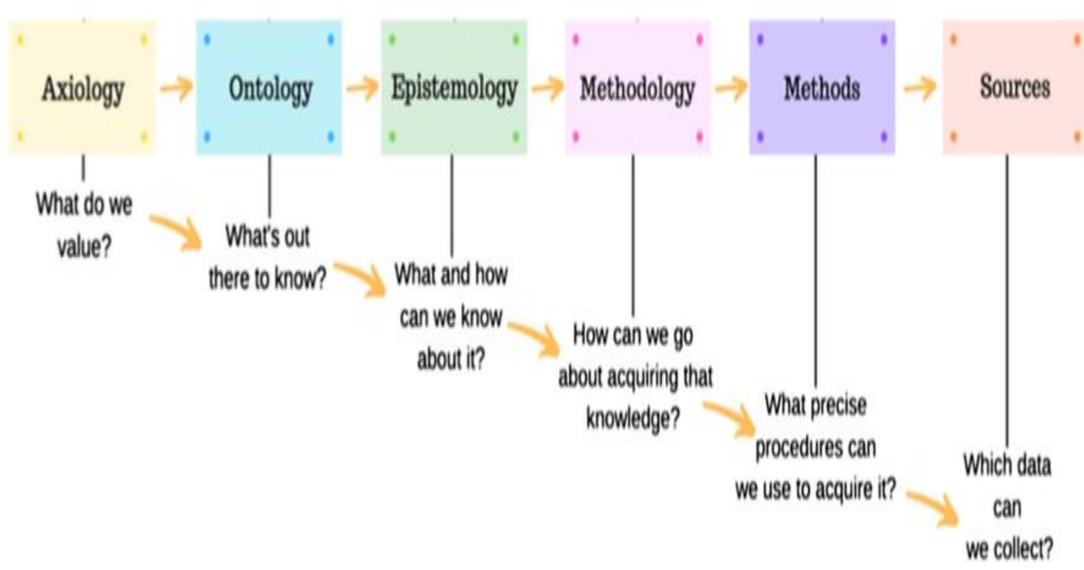

Figure.3.2: An adapted version of Grix's paradigmatic building block (Brown and Dueñas, 2020)

Both representations show the different layers or stages which contribute to producing an effective methodology.

Having considered both approaches, the researcher has chosen the paradigmatic building block (Brown and Dueñas, 2020) as the components are more widely applicable to the research. It also helps to visualize and understand the different elements of a paradigm that was considered to produce an effective methodology. This has been presented as a metaphor by (Varpio *et al.*, 2017) where the research paradigm is the glass box in which the researcher stands, framing how he/she sees the outside world. Belief about ontology and epistemology of knowledge will paint the glass box in different ways shedding different lights to the same situation to different people.

3.2 Development of Theoretical Framework and Related Research Options

3.2.1 Research Paradigm

Research paradigms are assumptions and intellectual structures which make up research and development in a field of enquiry (Bogna, Raineri and Dell, 2020). It is the theoretical perspective and an aspect of the research that shapes the way the research is formed as well as implemented. It is a world view about conducting research i.e. a set of common beliefs scientists share among themselves about how to understand and address problems (Brown and Dueñas, 2020).

Research activities such as data collection, analysis, and the relationship between participants and researchers are all influenced by the chosen research paradigm. The most common research paradigms are positivism, pragmatism, constructivism and interpretivism. Each of these can be further categorized by viewing their epistemology, ontology, and methodology.

3.2.2 Axiological approach

Axiology is the study of values and ethics (Brown and Dueñas, 2020). It involves ethical considerations especially at the early stage of a research project. It asks the following questions: what do we value? What ought to be in research? Axiological considerations are best done during the planning stage of the project where the researcher reflects deeply more on the researcher's motivations and what the researcher is trying to achieve, asking such questions as motivational factors for the research (i.e. what motivated this research?) – is the researcher motivated because of what is observed in the surrounding or a political topic the researcher want to research on or simply a quest for knowledge? In this case, the researcher's interest in the Aba reuse system motivated this research. The researcher developed an interest in construction waste management while she spent part of her life in the city of Aba where it was observed that almost every street in Aba south local Government has turned to a potential reuse market extension for waste. One cannot discuss waste reuse in Nigeria without talking about Aba waste workers. They are hardworking and depend less on government interventions. This was more of a lifestyle rather than perceived poverty.

3.2.3 Ontological Approach

Ontology is the theory of relationships between items which embraces many types of items (including abstract and non-existent). Ontological assumptions are concerned with what constitutes reality, in other words, *what is*. It is the duty of researchers to decide what they perceive about how things really work and what things really are (Scotland, 2012). Some spectrums of ontological options are relativism and realism.

Relativism holds that there is no pre-existing reality other than those created and accomplished by the social actor (Patomäki, 2020). On the other hand, Realism posits that there are social prodigy and realities that exist independent of the social actor (Kim, 2019).

To decide whether to apply realism or relativism to the current study (perception of key actors on the drivers and barriers to CDW management in Nigeria: a framework for the recognition of the informal sector) the following factors have been considered:

- The research focuses on perception of key actors on the drivers and barriers to CDW management in Nigeria and aim to investigate the potential for reuse and recycling of CDW in Nigeria with specific focus on the role of informal waste workers in facilitating this.
- The research focuses on an existing concept; however, the concept is not fully embraced in the country under consideration – Nigeria.

This leads to an assumption that there is an existing means of finding out the barriers to reuse/recycling whether we know it or not. Based on the above, a relative ontology (which assumes that there is no total validity) is not considered an appropriate foundation for this research. Therefore, a Realist ontological belief is perceived as suitable for this study. Following this ontological belief, it means that there is an existing truth about construction waste management methods, whether it is known or not. So, the quest should focus on finding real evidence.

3.2.4 Epistemological Approach

The epistemological approach influences the various decisions a researcher will need to make about theoretical framework and (therefore methods) that will be used to carry out the research i.e.

assumptions we make about how knowledge can be obtained. The assumptions we make about how knowledge is acquired will determine how we go about acquiring it.

In the bid to interpret and understand an idea or occurrence, there are two basic approaches that can be used. These are the objective and subjective approaches (Killam, 2013). The objective approach holds the view that the investigators or researchers should be able to independently study the research object without being influenced or without influencing the object. As a result, researchers normally use predefined tools like questionnaires, interviews etc. to collect data. On the other hand, subjective research requires the researcher to interact with the subjects of study in order to acquire knowledge to the study (Killam, 2013) i.e. it does not require research instruments.

3.2.5 Theoretical Framework

Concept of theoretical framework

The theoretical framework is the foundation from which all knowledge is constructed for a research study (Grant and Osanloo, 2014). A theoretical framework is the most important aspect of developing a research process yet choosing and applying a theory that fits the research is a challenging task. No one theory best fits with any enquiry but it is the duty of the researcher to select a theory which will align with and support the structure of the thesis' aim and objectives. Each discipline has certain popular theories; however, one can equally borrow a theory from another discipline (Grant and Osanloo, 2014). The choice of theory will provide a common worldview or lens from which to support the researcher's thinking of the research problem and data analysis. The selected theory must be applicable, appropriate and must have an explanatory power.

Theoretical framework can either be developed prior to analysis or during data analysis stage of the research (Grant and Osanloo, 2014). Utilizing theoretical framework prior to or during analysis can equally be employed in quantitative, qualitative, or mixed method designs (Grant and Osanloo, 2014; sangadah and Kartawidjaja, 2020). Moreover, theoretical framework can be borrowed from another discipline (Larsen and Adu, 2021). A growing trend in the social sciences is borrowing theoretical constructs from other disciplines. Building theoretical framework from another discipline is an effective way of fully engaging in a research topic (Grant and Osanloo, 2014).

The application of the theories for reanalysis followed abductive research where findings emerging from previously collected data were discussed based on theories (Vila-Henninger *et al.*, 2022). Abduction thereby provided both epistemology and a method of analysis for this study. Abductive research practice has severally been adapted by several qualitative scholars to reanalyze qualitative data sets and thus perform qualitative secondary analysis (Mann, 2011; Vila-Henninger *et al.*, 2022).

This research work was approached in two phases: phase (1) the exploratory stage and phase (2) the explanatory phase.

Establishment of phase 1 (Exploratory)

Phase 1: In phase (1), the results (survey and interview), which were more technically focused, were further analysed using theory of planned behaviour (TPB). This revealed that there was a deeper social focus which needed an alternative approach for phase 2. Hence, theory of recognition chosen for further analysis of the third result chapter (ethnography), which becomes the phase 2 analysis. The discussion of the appropriate theoretical framework to apply for this phase is in Section 3.2.4.1.2.

Establishment of Phase 2 (explanatory)

Phase 2: Based on the findings from phase 1 (which is related to the chosen theoretical context), the Theory of Recognition was found most suitable for further analysis of the findings of phase 2 because it speaks of human needs to be recognised. Moreover, findings from analysis of third result chapter (ethnography) connects to emancipation and support of informal waste workers towards sustainable waste management in Nigeria. The theoretical framework also aligns with researcher's belief or world view and epistemology (this research earlier followed an inductive method of enquiry which have been discussed in Section 3.2.1).

The theory of recognition has been mostly applied in public health fields (Nancy Fraser, 2003; Thomas, 2012; Thomas O'Brien, 2013; Mitchell, 2021). However, one of the criticisms of recognition theory is that modern norms of recognition are frequently not recognised in practice, so that the resultant misrecognition is an obstacle self-realization or identity formation, which leads to social conflicts (Mark, 2014). This is because, although societies possess the right norms in the abstract, this conception of what these principles entails are too narrow.

3.2.5.1 Theoretical Perspective of Construction and Demolition Waste (CDW) Management

Consideration of theoretical options – for phase 1 and phase 2 - brief intro to planned behavior, diffusion of innovation and theory of recognition.

There are several theories that inform and support an understanding of the scope of CDW management. The researcher considered the theory of planned behavior (TPB), Diffusion of Innovation theory (DOI), and theory of Recognition (ToR).

Theory of planned behavior (TPB) is a popular behavioral theory developed by Prof. Icek Ajzen (1985). It is one of the commonly used foundational theories to explain the intentions to employ new technology by construction practitioners (Kabirifar *et al.*, 2020). It is a theory that seeks to explain how people's beliefs are linked to their actions or behavior. TPB theorizes actual behavior as a direct function of behavioral intention, subjective norm, weighted sum of attitudes and perceived behavioral control (Arli *et al.*, 2020). The main highlight of the theory of planned behavior is to encourage positive waste minimization culture and positive behavior towards construction waste management.

Diffusion of Innovation theory (DOI) was developed by Prof. Everett Rogers in 1962, and it is one of the oldest social science theories. Rogers defined diffusion as "the process in which an innovation is communicated through certain channels over time among the members of a social system" (Sani, 2022). DOI theory aims to explain how, why, and the rate at which a product, service, or process spreads through a social system. DOI has been applied in many fields (Lien and Jiang, 2017), including construction management fields (Larsen and Larsen, 2007; Taylor, 2007; Kale and Arditi, 2010; Esmaeili *et al.*, 2012).

Theory of recognition (TOR) – proposed by Prof. Axel Honneth (1995), is based on the human struggle to be recognized. It is a social philosophy that recognizes love, rights (legal) and solidarity as building blocks for self-confidence (Thomas, 2012).

Much has been written over the years on construction waste management through the informal waste workers in section 2.6.3. Yet, the outcomes from using the theories are not distinct. This research contributes to knowledge by proposing the use of recognition theory as a useful lens for understanding informal waste workers role in CDW management in Nigeria (Section 3.2.4.1). Some of the concepts derived from the theory such as love, law and solidarity (which is discussed in full detail in Section 7.3) served as labels representing "lay" description showing or exemplifying important aspects of the study (Larsen and Adu, 2021). Hence, legal factors such as law on waste management, shift in policy interest to environmental protection were threaded with concept of law/rights, social factors such as recognition and certification of informal waste workers were threaded with concepts of solidarity. Love, which is more of a familial concept, is not relevant in this research.

Findings from the analysis of both the quantitative and qualitative data of this research have helped to inform the choice of theoretical framework. As earlier mentioned, the theoretical framework was used to modify, support, and extend the findings in chapters four, five and six. Thus, it helped to align the findings in phase 1 to an existing theory (theory of planned behavior), while principles and concepts of recognition theory were threaded throughout phase 2 analysis. This was used as a guide for logically developing and understanding the different, yet interconnected parts of the findings (to interpret the findings and underlie recommendations).

While determining how potential theories could assist in analyzing the study, the researcher selected theories which accurately and completely represent the role she wants the framework to play in the study. The first analysis, (where the findings were organized into themes), was where recognition of informal waste workers emerged in the data. This allowed the researcher to expand and critique the topic in a new way using theory of Recognition. Ideas arising from the theory of recognition was used to add to the understanding about the contributions of informal waste workers towards better CDW management in the Nigerian construction sector. Hence, the theoretical framework for this study helped to narrow the focus of the study to an aspect that is reachable and doable (Larsen and Adu, 2021). Here, the epoche` practice where the researcher suspends the explanatory validity of a theory and use its concept and terminologies to help describe the relevant information captured from the data (Larsen and Adu, 2021), i.e. the theory becomes a descriptive tool. The choice of the theory was informed by the specific findings as presented by the exact words of participants and the researcher's thought process (Larsen and Adu, 2021).

Figure 3.3 shows the phases in which this study was carried out. There are generally two phases:

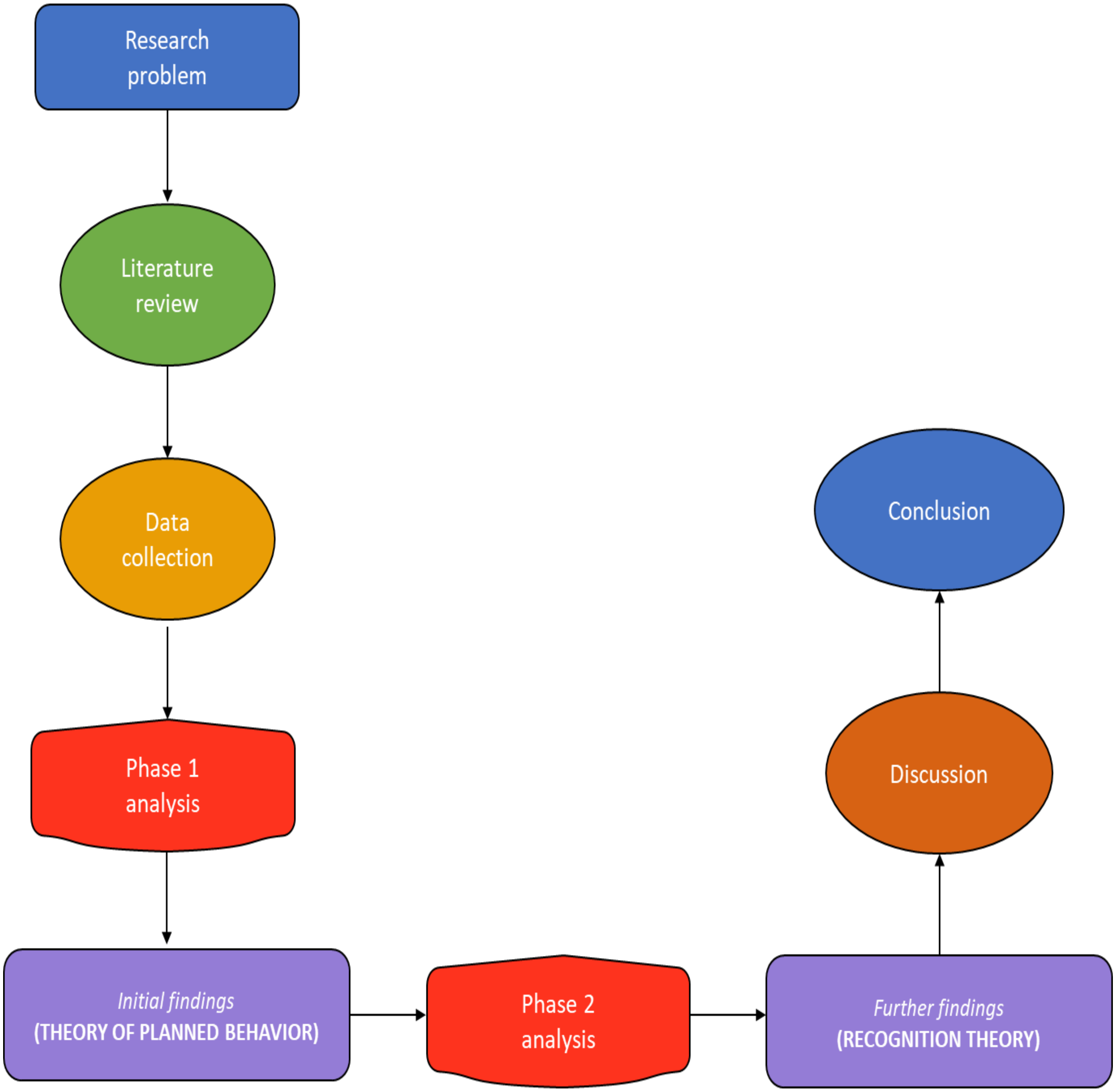

Figure 3.3 Concept mapping of theoretical method of analysis.

3.2.5.2 Theory for phase 1 (Theory of Planned Behaviour)

Theory of Planned Behavior (TPB) is a popular behavioral theory developed by Icek Ajzen (1985). It is a theory that seeks to explain how people's beliefs are linked to their actions or behavior. It has been applied to studies of the relations among attitudes, beliefs, behaviors, and behavioral intentions in various fields. TPB theorizes actual behavior as a direct function of behavioral intention, subjective norm, weighted sum of attitudes and perceived behavioral control (Arli *et al.*, 2020).

TPB is one of the mostly used foundational theories to explain the intentions to employ new technology by construction practitioners (Kabirifar *et al.*, 2020), and of the factors which underpin these choices. According to the theory, behavioral intentions is a function of attitude, behavioral control and subjective norm, meaning that the actual behavior of construction industry practitioners to adopt an innovation (such as waste management via reuse and recycling of CDW) is a direct function of this behavioral control.

Attitudes, according to (Lamba and Sharma, 2021) is a relatively enduring organization of feelings, beliefs and behavioral tendencies towards socially significant objects, groups, events or symbols. Attitudes can also be seen as evaluative judgment which can be described in three ways; behavioral, affective and cognitive (To, 2022). Attitudes are influenced by people's perception about something or people's disposition and reaction about an object, hence, they tend to be positive or negative. Subjective norms involve culture or perceived social pressure /social value (how desirable or not others see the action). Perceived behavioral control is how difficult or easy we perceive an action to be. Here perceived behavioral control encourages positive waste management behavior among the Nigerian policy makers, construction practitioners and citizens.

TPB is a framework which encourages people to alter their behaviors with the aim of decreasing harmful effects of waste on the environment through sustainable waste management (Heidari *et al.*, 2018). This can be created by provision of technologies such as waste management facilities, provision of markets for waste and the need for construction stakeholders to imbibe waste management cultures. If the driving forces for construction waste production are understood, then it could help stakeholders to be more aware of more sustainable methods to manage it.

Throughout history, humans have produced waste which they found difficult to manage properly. Like many other environmental problems, human behavior is the main cause of construction waste, making it a behavioral and social problem (Grilli and Curtis, 2021). Likewise, beliefs determine behavioral control since the belief in accessing resources without much obstruction supports construction waste management. This denotes that the more resources people believe they have, the less obstacles they anticipate and the more perceived behavioral control over the behavior (Audu *et al.,* 2020). Hence the perceived lack of waste management facilities will influence construction waste management in Nigeria.

Therefore, for sustainable waste management in Nigerian construction industries, the industry practitioners require a positive attitude towards innovations such as reuse and recycling of CDW.

3.2.5.3 Theory for phase 2 (Recognition theory)

Recognition theories are mostly associated with the works of Honneth (1995, 1996, 2004, 2007, 2010), Taylor (1994), and Fraser (2000, 2001, 2003). Some dimensions of the theory focus on group identity and redistribution of power while other parts focus on the idea of common humanity (Thomas O'Brien, 2013). Honneth's idea of recognition focusses on self-identity which thrives in the context of social relationship, characterized by reciprocity (reciprocity suggest the recognized and the recognizer have crucial role in mutual relationship which reflects successful acts of recognition) (Thomas O'Brien, 2013). Recognition theory revealed that social ties are very important to people, and it can be expressed in many ways.

Recognition has different meanings. Recognition can be seen as; a form of identification; as the act of acknowledging someone's achievements or status or rights; as an act of intellectual apprehension. Hence, recognition is crucial for valuing a person or a group of people and for understanding ourselves. Taylor (1994) refers to it as a vital human need (Kaluarachchi, 2018).

Historically, there was a struggle for the recognition of the rights of the great masses or for the recognition of some nations. Also, in recent times, as societies change constantly, minorities or small groups seek recognition. Axel Honneth identified three areas of human recognition: love, law, and solidarity; none of these is more important than the other.

Love: The emotional dedication (love) is the first stage for the reciprocal recognition, being restricted to primary relations, i.e to the strong emotional connections between a few people such as the relation between two partners, friends and parents and their children. In the reciprocal loving relationship, subjects know they are united by the fact they are co-dependent in their state of needs and feelings of the other, in a precarious balance between autonomy and connection (Nancy Fraser, 2003). This concept, however, is not within the coverage of this research, hence, the focus will be on rights and solidarity.

***Rights**:* When Honneth talks about rights, it implies the authority granted to each citizen as members of a community. Rights recognition stems from the legal side where one's autonomy is recognized. Here, basic rights as a citizen of Nigeria denotes the fundamental human rights of the

1999 constitution of Nigeria (Anazonwu *et al.*, 2022). Juridical recognition takes place through the respect to the attributes that make the individual a morally imputable person. Such attributes are grounded in universalist moral principles and on a cognitive understanding that undergoes through processes of historical evolution. In these processes, not only the extension of rights to social groups that have been, so far, excluded from the status of being a rights-bearer, is present but also the extension of content (Honneth, 2003). Individuals or a group of people are recognized with a sense of moral authority and perceived respect, as being human or holding equal opportunities to others. Recognition in the form of having rights makes one feel (in a fundamental way), equal to other individuals. This in turn, gives rise to self-respect. The opposite, misrecognition of rights, gives rise to denial of an individual or a group of individuals' right to participation, speech, freedom, of movement, to have one's view not taken into consideration, thus making one unrecognizable. Social struggles expand different rights and duties; therefore, we identify in this area when people's moral ability to take their own actions they are not legally recognized and enabled to exercise their rights and make their own decisions. A sign of poor recognition could be the feeling where a cultural group feel marginalized (for example, the feeling of being marginalized by informal waste worker in Nigeria.

Informal waste workers in Nigeria are often denied their basic rights, this pertains to those that make life worth living – such as the right to education, dignity of human person, right to freedom from discrimination, the right to fair wages, safe working conditions, and access to healthcare (Srivastava, R. R., & Pathak *et al.*, 2012; Mbah and Nzeadibe, 2017b; Cruvinel *et al.*, 2019).

***Solidarity*:** Solidarity form of recognition arises as part of concern felt for value of others (Pereira and Teixeira, 2012). The community where one is part of recognizes him/her for their contribution, strength, and ability. This recognition in turn builds their self-esteem. When people feel unrecognized in their place of work, neighborhood, or community, then the sphere of solidarity breaks. This results in stigmatization which impacts one's honor and dignity. However, the opposite such as disparagement, insults, and belittling leads to impairment of self, shame and dishonor (Mitchell, 2021). Solidarity involves the acknowledgement of an individual's social and cultural identity and their contribution to society. Informal waste workers in Nigeria are often excluded from mainstream society and are stigmatized as "dirty" and "uneducated" (Yu, Blaauw and Schenck, 2020; Jiboku, Jiboku and Babasanya, 2021). This exclusion undermines their sense of belonging and identity and hinders their ability to contribute to society.

In many societies where the level of inequality is high, such as the Nigerian one, the great majority of people is daily disrespected through symbolic violence mechanisms. Honneth (2003) argues that the experience of disrespect could become the motivational impulse for the struggle for recognition once the affective tension from the injury of humiliation could be dissipated in the chance of active action. Such feelings could become the motivational ground for collective resistance when the subject can articulate them in an inter-subjective frame of interpretation that proves them as they are experienced by a whole group.

3.2.6 Research Methodology

Research methodology explains how the researcher can acquire knowledge to align naturally with the chosen research paradigm. (Brown and Dueñas, 2020) sees it as "research strategy or the overall plan to acquire knowledge". Whatever you are seeking to achieve will determine your methodology i.e., the belief about how data (about a phenomenon) should be collected, analyzed, and used. It serves as a lens to view and interpret issues and serves as principles guiding research approaches (Saunders, M., Lewis, P. and Thornhill, 2012). For each stage of the research process, there is an assumption about the nature and source of knowledge.

For research to be completed, knowledge must be created. Primary and secondary data will be collected and analyzed to answer a research question and in answering this question and new knowledge is created. These can be positivism, interpretivism and pragmatism (Melnikovas, 2018). Positivist approach collects quantitative data using objective research methods such as questionnaires, experiments, and interviews. While interpretivism focus on gaining "subjective" knowledge where individuals or small groups are analyzed in-depth through detailed discussions and observation while pragmatism allows a mix method which works best in finding answers to research questions under investigation.

Positivism: Positivists supports the use of natural science methods to study social sciences (Debele, 2019). The main aim of positivist enquiry is to predict and control through the identification of relevance factors to ascertain reasons and results of certain associations (Ryan, 2018). Positivists argue that real knowledge is gotten from logical and mathematical approaches. They believe that knowledge derived from universal laws is constant.

Interpretivism: Interpretivism is rooted in anthropology. It is the opposite of positivism, sometimes regarded as anti-positivism. Interpretivists argue that knowledge is subjective, based on history and culture, i.e. based on people’s experiences and understanding of them (Ryan, 2018). This means that the way researchers collect, interpret, and analyze data depends on their own values and beliefs. As Peck and Mummery (2018) indicate “Experience doesn’t often speak for itself, the language bring to it does” Interpretivism relies on natural methods of data collection like observation and interviews. Also common with interpretive philosophy is secondary data collection.

Pragmatism: Pragmatics recognizes concepts to be relevant if they support action (Kaushik and Walsh, 2019). Pragmatism is concerned with real world problems (Fetters, Curry and Creswell, 2013). Pragmatics believe that there are multiple realities and that there are many ways to undertake research and understand the world. Pragmatics believe that the research philosophy employed should depend on the research question. Pragmatics can employ both positivism and interpretivism philosophy within the same research, thereby integrating multiple research methods such as quantitative, qualitative and action research methods. This denotes that they combine whatever methods are deemed necessary to answer the research questions and carry out the research successfully.

Methodology approach for this research:

Positivism fits into this research as the researcher earlier employed questionnaire and interviews to collect data about reuse and recycling of CDW from construction participants in Nigeria. At the later part, interpretivism was employed as in-depth interviews from politicians who have a stake in the construction sector and observation of informal waste workers in Nigeria. Since both methods are required, pragmatism is the adopted approach for this research.

3.2.7 Methods

The researcher collected both quantitative and qualitative data to satisfy all the research objectives. A structured questionnaire survey (Appendix A) was selected to collect quantitative data in this research. The methods used to collect qualitative data were semi structured interviews (Appendix B) and proxy ethnography (Appendix C). Each of the specific methods are described in Section 3.4.

3.2.8 Sources

Having discussed the research methods, it is important to know what kind of data will be collected. In this research, quantitative (numerical) and textual data was collected from survey responses, audio data from interviews, textual data from literature and transcribed audio, pictures and videos also served as data. Data collected can be considered as primary and secondary, according to the source of collection:

Primary data: also known as raw data, was collected firsthand from the source. Here, the researcher was the first person that collected and drew conclusions from it.

Secondary data: was collected and analyzed by another person and is often obtained from books, journals, research papers etc.

3.2.9 Overview of Research Approach

Having described and defended the adopted philosophical stand and research strategy, the following section presents a detailed account of the research methods adopted for the collection and analysis of data. The researcher considered the following research methods; interviews, survey, ethnography, case study, content analysis, experiments, focus groups, exploratory research, grounded theory, literature review, thematic analysis, and action research. Among these, the researcher chose literature review, questionnaire survey, interviews, and ethnography methods because these methods rightly answer the research questions and satisfies all the research objectives. Table 3.1 provides an overview of the research process which includes the relationship between research objective, method of data collection and the philosophical stands. Table 3.3 represents the relationship between the research objectives, research philosophy, research strategy and the research methods.

Table 3.1: Relationship between research objectives, philosophy, strategy, and methods

No	Research objectives	Research philosophy	Research strategy	Research method
1	Review best practice relating to reuse and recycling of CDW globally in the context of the existing design and construction processes.	positivism	Quantitative research	Literature review
2	Analyze current practices relating to reuse and recycling of CDW in Nigeria	positivism and interpretivism	Quantitative research	Literature review, Questionnaire, interviews, theoretical framework (phase 1)
3	Investigate barriers to reuse and recycling of CDW in Nigeria	Constructivism &interpretivism	Quantitative and qualitative research	Literature Review, questionnaire survey, interview, ethnography.
4	Identify the drivers for effective CDW management in Nigeria	Constructivism &interpretivism	Quantitative and qualitative research	Lit. Review, questionnaire survey, interview, ethnography.
5	Evaluate the role of informal waste workers in reuse/recycling of CDW in Nigeria	Positivism, constructivism and interpretivism	Quantitative and qualitative research	Literature review, questionnaire, Interviews & ethnography, theoretical framework (phase 2)
6	Identify the interrelationships and needs of the informal sector, as a basis for generating a framework for the recognition of the informal sector in the reuse and recycling of CDW in Nigeria	Positivism, constructivism and interpretivism	Mixed research	Ethnography, theoretical framework (phase 2)

3.2.10 Ethical Consideration

In every research, ethical issues with regards to the protection of participants is a thing of concern. Though vulnerable groups (such as underaged, disabled) were not part of the research, reasonable efforts were made to protect and inform the participants in an ethical way. Consents and permission from participants were gained following ethical guidelines, as well as making sure the anonymity of participants was maintained. Before participating, written consent of participants was sought and their right to withdraw or not to answer certain questions were clearly made known. Moreover, the researcher solely secured and managed the research related data. Research Ethics Approval was gained from Cardiff university's Research Ethics Committee, and this was approved. The approval letter(s) for both interview and ethnography are included as an appendix (Appendix D)

3.3 Research methods applied.

The following section presents a detailed account of the research methods adopted for the collection and analysis of data.

3.3.1 Questionnaire Survey

A questionnaire survey is particularly useful when:

- A large sample needs to be surveyed.
- Face-to-face contact is not essential.
- Limited funds for the research

Surveys can be used to capture a snapshot of a section of the society at a particular point in time with the aim of generalizing the result for the relevant population (Deme Belafi, ZHong, TReith, 2018). The choice of online surveys reduces research costs as well as covering a wide geographical area. The researcher prepared a questionnaire based on literature review findings. Appropriate respondents were contacted via professional groups (such as Nigerian institute of Architects, Nigerian institute of Engineers and Nigerian institute of Quantity surveyors), construction company websites, as well as via Facebook, WhatsApp, professional contacts and referrals etc. A total of 150 potential participants were directly contacted by the researcher. Each was asked to forward the questionnaire onto other relevant personnel – a method known as "snowballing". The number reached by this method is not known.

3.3.1.1 Questionnaire Design Strategy

One common problem associated with the use of a questionnaire is that it is difficult to control and predict the response rate. Therefore, to ensure high response rate, the following recommendations were employed in this research:

- Clear, concise, unambiguous, and easy to understand and answer questions.
- The questionnaire is uncluttered and attractive.
- Questionnaire prepared to prevent possible biased terms.
- The pilot questionnaire was tested by a review group and refined based on their feedback.
- All direct contacts received a personal message with the invitation to participate.
- A cover letter included in the questionnaire. The cover letter included a brief introduction of the research in question, aims, approximate time and ethical matters.
- The questionnaire was sent electronically as this was considered the easiest way for participants to respond. The first set of responses came in immediately while a follow up reminder was sent to non-respondent monthly.

30 paper copies were also sent directly to relevant professional colleagues, however, only 2 copies returned. A total of 98 responses, out of 150 direct invitations were returned. This gives a response rate of 65.3% based on direct invitations. This high response rate could be attributed to the actions above. It was noted that there was a better response to the electronic survey (80%) compared to the paper survey (6.7%). The electronic method also makes it easier to incorporate the snowball approach.

3.3.1.2 Questionnaire Structure and Content

The questionnaire (directed to practicing construction practitioners) was made up of 20 questions. The questionnaire is divided into nine (9) sections:

- **Section 1; background information:** Questions regarding the profession and size of company were asked to gain an insight into how these factors influenced the participants' opinions and allow for analysis of the final research population.
- **Section 2; amount of CDW:** Questions regarding amount of CDW were asked to gain insight to the amount of CDW produced by Nigerian construction firms and current best practices relating to managing waste materials.
- **Section 3; causes of CDW**: Questions regarding causes of CDW were asked to gain insights into the root cause of CDW in the Nigerian construction firms and best management practices.
- **Section 4; strategies to reduce CDW:** Questions regarding strategies to reduce waste were asked to have insights into different strategies employed by the Nigerian construction companies to reduce CDW.
- **Section 5; drivers to reuse/recycling:** Questions regarding drivers CDW reuse and recycling were asked to have insights into Nigerian construction company's perception of drivers to reuse and recycling of CDW and the willingness of construction professional to implement it.
- **Section 6; barriers to reuse/recycling of CDW:** Questions regarding barriers to CDW reuse and recycling were asked to have insights into Nigerian construction company's perception of barriers to reuse and recycling of CDW and possible solutions.

- **Section 7; waste management strategies:** Questions regarding waste management strategies were asked to gain insights into the various waste management practices employed by the Nigerian construction firms and proffer best possible waste management strategy in the Nigerian context, including the role of informal waste workers in reuse and recycling of construction and demolition waste (CDW)
- **Section 8; effect of CDW on the environment and:** questions regarding effect of CDW on the environment were asked to gain insights on the negative effects of CDW on humans and the environment.
- **Section 9; effect of CDW on the economy:** Questions on the effect of CDW on the economy were asked to gain insights on the cost effects of CDW on companies, government, and private clients.

3.3.2 Interviews

Qualitative interviews provide a means to delve into the beliefs, experiences, and identities of participants (Keiler, 2018). Depending on the research objectives, structured, unstructured semi structured interviews or focused group interviews can be employed. Through in-depth interviews with participants, new concepts can emerge. This approach allows researchers to go beyond predefined factors that may not encompass the scope of the subject matter.

Interviews can be aligned with phenomenological or experimental research paradigms (Muzata, 2021). Interviews possess qualities that set them apart from methods (Essa Adhabi & Christina Blash Anozie, 2017). Engaging in interviews requires commitment from both the researcher and the interviewees. Moreover, it demands resources and time allocation. With the advancement of technology, implementing interview processes has become more flexible. Has moved away from face, to face interactions. However ethical concerns and challenges are also associated with conducting interviews as researchers encounter dilemmas throughout the research journey.

The different types of qualitative interviews are presented in Table 3.2.

Table 3.2 Interview types

INTERVIEW TYPES	
	Controlled way of getting information from participants. Interview is preplanned as the researcher writes down the interview questions such that the interview is tightly focused on the topic in question. Best for an interviewee who knows exactly what he is looking for. A disadvantage to this method is that it limits the availability of in-depth data (Karaoğlan, Ustun and Yilmaz, 2020).
Unstructured interview	The opposite of structured interviews in that the interview method is flexible. The interviewee has options or choice as to what extent to respond to the questions (Pandey and Govind, 2014).
Semi structured interview	A mixture of both structured and unstructured interview methods. Here the questions are preplanned but the researcher, using open ended questions gives the interviewee the opportunity to elaborate particular issues (Mann, 2011). This interviewing method is recommended for researchers who have an overview of their research topic, hence pilot study is always recommended. In this research, semi structured interview method was employed as it helped to get the depth and richness of responses (Sim and Waterfield, 2019).
Focused group	Different from the above interview types but shares the same characteristics. It is usually a group interview where the group (of about 6-12 members) are brainstormed in order to generate high quality which is beneficial to the researcher (Adler, Salanterä and Zumstein-Shaha, 2019). It is employed for sensitive topics (Sim and Waterfield, 2019).

3.3.2.1 Sample and Sampling Techniques

The study focusses on construction and demolition waste in Nigeria. So, participants who have a stake in the construction industry were targeted (i.e., politicians with professional background in construction). The purposive sampling technique was employed to identify 30 potential participants of whom 12 accepted. All the participant works as heads of different parastatals. These interviewees represent two groups: government officials (2 commissioners for works and housing, 2 directors of state environmental protection agencies) and the second group, 8 construction industry consultants (including contractors, professional bodies directors, civil engineers, environmental consultants), who were selected across the country these participants were selected based on their familiarity with the construction industry and also considered to have adequate knowledge in informal recycling. Their selection also maximised the depth and coverage of interviews and as well, prevented bias results. All the participants have had an average of 15years work experience in the construction sector having diverse and multiple roles. Each of them also has their private practices in the construction sector. The researcher considered the comfort level of participants. Before conducting the interview, the participants were invited through a written invitation online through mobile phone calls, through mail, Facebook messenger and WhatsApp**,** explaining the aim of the study. The participants preferred these methods rather than zoom and skype meetings because they were so busy and not comfortable to create their own accounts simply just to participate in interviews. WhatsApp was always readily available and all networks. They were also informed of the scope and nature of interview discussion before scheduling the interview.

Below are the roles/backgrounds of each participant.

Participant #1- Civil Engineer

Participant # 2 - Quantity Surveyor

Participant # 3 -Civil Engineer

Participant # 4- Civil Engineer

Participant #5 - Civil Engineer

Participant #6- Building Technologist

Participant #7 - Quantity Surveyor

Participant #8 -Quantity Surveyor

Participant #9 - Architect

Participant #10 - Architect

Participant #11- Civil Engineer

Participant #12 - Quantity Surveyor.

3.3.2.2 Method of Data Collection

Several studies have used qualitative interviews to improve understanding of complex issues in construction waste management (Nzeadibe, Anyadike and Njoku-tony, 2012; Ahmad, Emam and Farrell, 2014; Akinade *et al.*, 2016; Mbah and Nzeadibe, 2017b; Kaluarachchi, 2018; Yukalang, Clarke and Ross, 2018).

Interviews for this research lasted an average of 30 minutes, via telephone and recorded with a mobile app. The semi structured interview addressed questions about (1) barriers to reuse and recycling of CDW in Nigeria, (2) how to make Nigerian CDW management sector effective, (3) how to enhance CDW reuse/recycling in Nigeria, (4) attempts to stop illegal dumping of CDW,

(5) economic incentives to support small scale companies to reuse/recycle and (6) how to include scavengers as they aid in CDW reuse/recycling. It is worth mentioning here that some participants declined to give their opinions because they believe that as far as government is involved, nothing will ever change irrespective of their opinion.

The interview data was transcribed, anonymised, and imported to NVivo, a software to facilitate thematic analysis. Relevant codes were developed by the researcher, thereafter, the data was coded. To ensure interpretive validity, the use of codes that represent the original terminologies used by the interviewees was employed. This increased overall reliability of the analytical procedure (Guest, MacQueen and Namey, 2014). The codes were reviewed followed by development of final code structure. The researcher categorized the responses, and the frequency of each category indicated the number of instances in which it appeared in the data. The relevant keywords from the interview script were grouped based on their significance. The coding process followed an approach capturing the elements of the collected information. Themes were defined by identifying commonalities among the codes. The developed themes were reviewed to ensure their alignment with the coded excerpts and the entirety of the interview document. Subsequently, each theme was assigned a name (political factors, social factors, financial factors and technical factors). The qualitative research findings were then compared to previous literature review findings, specifically to investigate the role of informal waste workers CDW management in Nigeria.

The researcher conducted further literature analysis for each theme, refining the essential elements and elucidating their meanings. The responses were categorized into topics, (each topic represents each question asked), while the chapter key findings were categorized into the initial themes (social financial political and technical themes).

Table 3.3 illustrates the relationship between themes, topics and codes

Topics	Codes	Themes
Barriers to reuse and recycling	Inadequate regulation High cost of CDW management Lack of technology for recycling Poor infrastructure	Political
Economic incentives support CDW reuse/recycling in Nigeria	Not aware of any	financial
How to make CDW management effective in Nigeria	Government and contractors to attach value to construction waste Improved technical capability and Employing contractors with large capacity (in terms of equipment and technical know-how)	Social Social
Attempts to stop illegal dumping of CDW in Nigeria	No attempts Yes, but the attempts are just discrete attempts, which are not specific to CDW	Political
Scavengers aid in Nigerian CDW management system	Government should organize all the waste workers (forming association of Nigerian waste workers), provide them with PPE's and provide scavengers with grants in form of financial aids.	Political

The interview Question is attached here as an appendix (Appendix B).

3.3.2.3 Issue of Reliability

Reliability is important to establish the quality and consistency of a research work (Fetters, Curry and Creswell, 2013). In a bid to increase the methodological reliability of the qualitative data, the research process was presented in detail to ensure this research work is replicable and that the research findings can be traceable to the data source. Also, data from interviews were considered against findings from literature as part of the analysis. Combining these approaches ensured proper exploration of the phenomenon. Although the interviews provided the biggest source of data, questionnaire survey, observations and construction professional bodies websites supplemented the data in understanding CDW management in greater detail.

3.3.3 Proxy Ethnography/Observation

Ethnographic research is qualitative research with different strategies and research methods to gather data, hence, is found suitable to understand the experience of the informal waste workers. Ethnography describes and interprets a cultural, ethnic or social group in their own environment through observation and interviewing (Plowman, 2017). Direct observation of a particular group can yield more valid data than self-reports (Martinussen, Højbjerg and Tamborg, 2018). One potential issue with ethnography is that the researcher easily gets overwhelmed with too much data.

Oral testimony is a painstaking interviewing method that stresses listening patiently, use of open-ended questions and documenting the behaviours/attitudes and perception of subjects- in this instance, informal waste workers. It is an inductive approach that focuses on meaning of words and images rather than numbers (Martyn Hammersley, 2017). It entails a detailed interest in events and processes and allows us to see things from the perspectives of those being observed. Social scientist make use of ethnography to understand the reason behind moral beliefs, economic lives, social changes and settlement patterns in a bid to bring about a positive change in the lives of people (Ebenso *et al.*, 2019), (Mbah and Nzeadibe, 2017b). The type of data gathered from ethnography is different from those gathered from other methods because ethnography describes and analyses a cultural situation (institutional, organizational, etc). Also, ethnographic writing is different from other types of academic writing about people and places (written with cultural contextualization in mind).

3.3.3.1 Data collection

The ethnographic method in this research involved participant observation and face to face interviewing (a particular group, the waste workers in Aba, were observed objectively). A field trip which was relevant for this research was planned but this did not happen due to COVID travel restrictions therefore, proxy ethnography was carried out instead.

Proxy means delegating some of the activities of observation to a third party. The observation was done by a colleague delegated by the researcher, while the interviewing was carried out online by the researcher. Here the proxy person is an academic person, a work colleague of the researcher who is familiar with the activities of the waste workers. Other uses of proxy can be found in (Plowman, 2017) where a manager is delegated to collect data in an electronic company.

The research instrument here is the proxy person. The one-to-one interviews were mediated by technology with the interactions undertaken using WhatsApp audio and video call. The interviews were recorded with a recording App, on a smartphone. The interview questions were generated from the literature. The researcher supported the proxy person in data collection by:

- Advising what needed to be observed in writing prior to the fieldwork.
- Providing interview questions to study before the observations
- Verbally repeating the advice while he was observing.
- Verbally responding to questions and suggestions from him.

This support also aided him a deeper understanding of the project. The proxy person made sure to follow the covid rules while observing.

The proxy person met with the participants face to face in their business environment. He requested oral consent before proceeding with the interviews. While trying to access to the people observed, the researchers employed emotional intelligence as they approached them with initial courtesy greetings and compliments. Subjects were informed that no question was compulsory. Where subjects declined to consent, the interview was discontinued happily. The proxy observer made sure to continue natural flow of conversation and ensured subjects felt at ease by making soft jokes when necessary. He started out with the background formalities and thereafter invited the researcher to interview the waste workers via phone or videocalls. Each interview started with exchange of pleasantries and introductions. The researcher then explained the goal of the research to the participant. The proxy person makes video of informal waste reuse and recycling processes and sent to the researcher. He listens to what is being said and ask questions. He also took pictures and recorded his site observations. The researcher thereafter deduced meaning from the pictures, videos and site recordings. Thus, studying details of the pictures and videos and applied her background knowledge to infer what is going on. The observation lasted for four (4) months from August to November 2021.

There were issues travelling to the location. These issues included roads which are not navigable by motor vehicles, this was exacerbated by excessive rain (8mm per day) on most days. Where roads were accessible, they were excessively busy (40minutes to travel 10 miles). This suggests the need to carry out this kind of research during the dry season (November until March). A further complication was curfew due to civil unrest (Biafra agitation). This was introduced every Monday and Wednesday all over the eastern part of Nigeria, for the duration of the study and till date. After reaching the location, it was not easy to access the waste reclamation area and observe/speak to the waste workers. Potential participants were afraid of sanctioning by the union if they give certain information. Some were also concerned that giving out information could potentially harm their business. This was because they were concerned it was untrue. Or because they were in doubt of what the information would be used for despite the provided explanatory information on the research. They believed that certain information when given out will affect the business in a sense that people will know the secrets of the business which will jeopardize their profits in the long run. This mistrust arises from the fact that most of the waste workers don’t understand the concept of research or the purpose of research. Some are just not interested due to ignorance. The language barrier was also a problem (those who could not speak English nor Igbo were not interviewed because of lack of an interpreter). There was a major issue with time. 30 minutes to talk was effectively lost either from their work or rest time.

Once access was gained, the next stage was to build trust and rapport by exchanging greetings, jokes, and pleasantries. Selecting key informants wisely was a challenge. Subjects were carefully selected according to their capacity, quality of their finished products and their willingness to talk. Some potential participants declined to respond because no immediate financial reward was offered - they believe that information is power, therefore should be rewarded. However, some people wholeheartedly agreed to providing information and claimed that their views reflected the opinion of the rest.

The interview consists of 17 Semi structured questions (attached in Appendix C). Each interview lasted for approximately of 30 minutes. The sampling method was convenient sampling where participants volunteered to give information. Snowball sampling method was also employed, where subjects recommended other waste workers.

The researcher conducted in-depth ethnographic interview with twelve (12) willing waste workers in Ndi Akpakara (Scrap Place) market in Aba city of Abia state, Nigeria. Among are, seven (7) informal waste recyclers, one (1) manufacturing company with 37 workers, three (3) waste recycling SMEs and one waste picker/scavenger. Two subjects in each group of waste material were interviewed until saturation (where no new information emerged). Subjects were purposefully selected to represent each construction waste material ranging from metal waste, wood waste, baggage, and cartons, and those that deal with multiple material waste. The participants are predominantly Igbo people, share the same cultural heritage, values, norms, belief, and language.

Working in a global pandemic requires ingenuity and exploring new methodologies. Lessons learned from this pandemic is that work will never be the same. Though there were covid issues, the participants were not particularly worried about that. Some subjects did not believe in wearing masks in very hot weather which limited interactions with them. Moreover, travel restrictions gave opportunity for transporters to increase transport fares. In Nigeria people tends to turn outbreaks such as the global pandemic to opportunities.

The interview included detailed experiences, opinions, views, and expectations of the waste workers on construction waste management in Nigeria. The interview was subsequently used to satisfy the fourth research objective. All the interviews were audio recorded and thereafter interpreted and transcribed verbatim to English words. The interviews were coded for analysis with NVivo software. The research involved continuous comparative analysis, interpretation of data collected and constant reflection on the research objective. It also involved analytical induction and writing reflective memos in the entire study.

Data was collected naturally, not disturbed by the researcher, and taking into consideration common sense knowledge, and analysis was of the cultural aspect of what is observed (Addeo *et al.*, 2019). This means that the researcher performed the role of a participant observer, employing common sense while interpreting and analyzing cultural aspects of what is observed.

The proxy observer's knowledge about the locale ensured a good response rate and helped to gain better access to personal and important information that might be withheld from strangers perceived as representing the government. The proxy person is a colleague (work colleague in Nigeria) of the researcher who is knowledgeable about reuse business in the city of Aba, and as a local, more likely to ensure a good response rate and this was one of the researchers' main motivations to doing it by proxy. The business activities of the waste workers include sorting CDW and reusing them skillfully. The researcher transcribed the recorded interviews herself (considering bias and mistakes that may arise with this medium). Doing the interpretation herself helped her to remember important information when listening again because a professional transcriber may miss details since they did not experience the interview (Terry *et al.*, 2017). This is especially important when subjects have an ascent or speak in a language that is not English. The researcher analyzed her findings using the inductive approach.

In Ethnography, there is no widely shared standard regarding what constitutes appropriate analysis or representation (Bracaglia, 2017). Ethnographers who do field work must develop strategies to manage and make sense of the large volume data they collected (Moser and Korstjens, 2018). As earlier stated, the approach of data analysis is chosen based on the research problem in question.

Data was analyzed using an inductive process of comparison of similar data emerging from interview questions. The researcher used visual media to accompany the analysis and presentation of results. This allowed the researcher to see the activities through the lens of the camera actively and passively to communicate what she has seen exactly the way she saw it. Videos were taken withing the set of ethical standards (Hannabuss, 2022). The ethnographic interview questions (Appendix C) were used to generate data about the culture of a particular group under focus.

The researcher coded the interview data into categories and sorted similarities and differences to determine relationships among categories. The data and responses here, includes gestures, surrounding objects, and other visual clues. The researcher submerged herself in the data to let the data speak. The results of the interview responses and observed naturally occurring conversations were presented in a variety of ways - with diagrams, figures, videos, and charts, together with quotations from interviews. Most of the participants were people with low literate level whose main medium of communication was Igbo Language (their native language).

Table 3.3 shows subject groups interviewed, number of participants in each group and waste materials reused or recycled by each group.

Table 3.4 Breakdown of participants by subject group

Subject groups	Material reuse/recycled	No of participants
Informal recyclers	Metals, wood, cement bags,	7
Manufacturing and Production Companies	Metals	1
Scavenger/waste picker	Metals, plastics,	1
SME’s	Metals, cartons cardboards, plastics, rubber, paper,	3

3.3.3.2 The Study Setting, Target Population and Research Team

Aba, the study city, is the commercial hub of eastern Nigeria. It had a population of over a million people in 2020 and is the most populous city in south-eastern Nigeria (Chima, Mariae and Stella, 2020). It has a thriving manufacturing sector and skilled artisans (Kwaskebe, Atolagbe and Kayode, 2021). Three huge attract traders from all over Nigeria and beyond made it a Centre of Commerce. However, there are many problems with waste management in Aba (Nzeadibe and Anyadike, 2012; Mbah and Nzeadibe, 2017a).

A large and dynamic informal system of waste recycling, involving mainly waste dealers and pickers exists in Aba. However, little is known about the activities of these waste workers. A typical waste worker in Aba is a hardworking businessman. His major economy is local crafts, trading, and laborer. Both young and old were patient and willing to work long hours (Chinazor Lady-Franca, 2016). The average waste worker had a primary or secondary level of education (Mbah and Nzeadibe, 2017b). He lives in a two-room apartment without basic facilities. Though without basic facilities, he tends to live up to expectations as a person in the working-class (Oguntoyinbo, 2012). Some live on the outskirts of the city while others live within the city. They have a high business acumen and work in all weather conditions with little protection (Oguntoyinbo, 2012). Their usual slang is ‘money matters’, meaning that making money is more important than anything else. Some of the waste workers are entrepreneurs who usually buy scrap materials from construction sites, junk shops and scavengers to sell to middlemen who in turn sell to manufacturing companies. It is a trade chain. Figure 3.4 is the map Abia state of Nigeria, showing the city of Aba which is the study area.

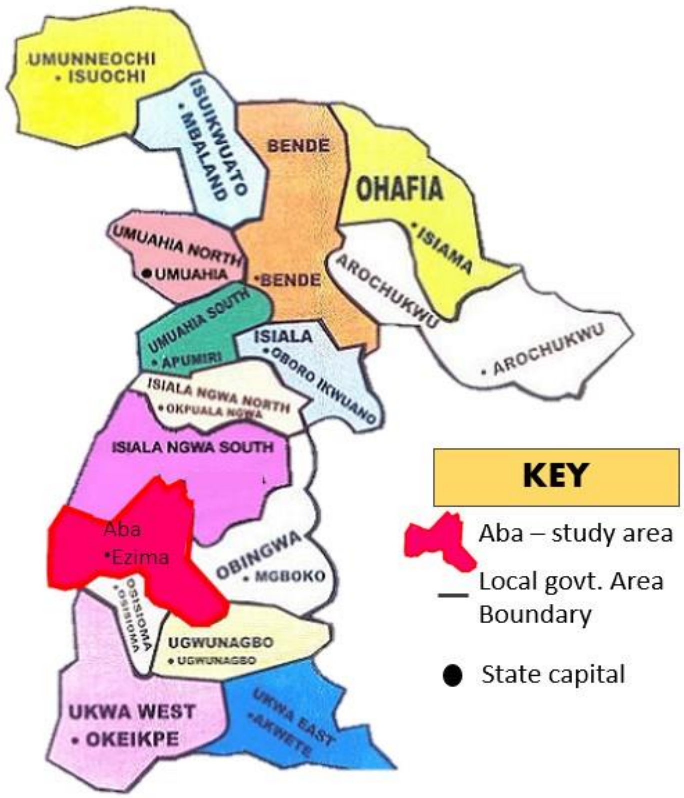

Figure. 3.4. Map of Abia State showing (Aba), the study area. Mshelbwala, et al. (2014)

3.3.3.4 Data Analysis Methodology – phase 1 – Theory of Planned Behavior (TPB)

The constructs below were adopted to evaluate the research findings in chapters 4 & 5.

In investigating the potential for reuse and recycling of CDW in Nigeria, several pertinent theories and concepts come into play. One of these is the theory of planned behavior (TPB). TPB provides theoretical framework for systematically identifying the factors which influence CDW reuse and recycling decisions for construction firms, government, and the masses. TPB is a framework to aid understanding and efforts towards sustainable CDW management. TPB demonstrates that people's intention to employ new ideas or new technologies is influenced by three interrelated constructs namely attitudes, subjective norm and behavioral control (Parker, Manstead and Stradling, 1995). The theory equally allows people with positive attitudes, who believe that there is adequate normative support and perceive that they can easily engage in activity, to have high intentions to carry out the behavior. Hence, the higher these intentions, the stronger the likeliness for people to behave according to those intentions (Parker, Manstead and Stradling, 1995). These efforts can only materialize with positive behaviors and high involvement of the masses towards the scheme. It is believed that this theoretical approach to the study setting (Nigeria) is reasonable because in African cultural contexts, social norms (Velis *et al.*, 2012; Wilson, Velis and Rodic, 2013) and perceived behavioral control can be main motivator of behavior.

Based on Ajzen's argument in the theory, it can be deduced that, before tackling CDW, we must understand how the industry practitioners, policy makers and the masses perceive the problem (construction waste) and their attitudes towards an innovation or waste management strategy (reuse and recycling). An understanding is required of the reuse and recycling choices made and factors which motivated the choices.

The theory provides an important model for identifying hidden factors influencing CDW reuse and recycling behaviors such as subjective norm and perceived control. Though findings from result chapter 4 and 5 revealed technical barriers to reuse and recycling of CDW - such as lack of recycling facilities, etc. While most see waste as inevitable. Theory of planned behavior encourages positive waste behaviors among construction practitioners, government and the public at large.

Discussion of the analysis using the TPB is found in Section 5.11

3.3.3.5 Data Analysis Methodology – phase 2 – Recognition theory

The constructs below were adopted to evaluate the research findings in chapters 6 & 7.

A general knowledge of waste management in developing countries acknowledges that sustainable waste management have been possible over the year through the participation of informal actors (Oguntoyinbo, 2012; Ferronato *et al.*, 2018). As earlier mentioned, theory of recognition was selected to serve as a lens to analyse the data at the second stage of analysis. Ideas arising from the theory of recognition was used to add to the understanding about the contributions of informal waste workers towards better CDW management in Nigerian construction sector. Concepts derived from the theory such as love, law and solidarity (which is discussed in full detail in further sections) served as labels representing "lay" description showing or exemplifying important aspects of the study (Larsen and Adu, 2021). This were now used to inform the interpretation of the findings from the analysis of the data. Hence, the theoretical framework for this study helped to narrow the focus of the study to an aspect that is reachable and doable (Larsen and Adu, 2021). Here, the epoche` practice where the researcher suspends the explanatory validity of a theory and use its concept and terminologies to help describe the relevant information captured from the data (Larsen and Adu, 2021), i.e. the theory becomes a descriptive tool. The choice of the theory was informed by the specific findings as presented by the exact words of participants and the researcher's thought process (Larsen and Adu, 2021). While determining how potential theories could assist in analysing the study, the researcher selected a theory which accurately and completely represents the role she wants the framework to play in the study. Legal factors such as law on waste management, shift in policy interest to environmental protection was threaded with concept of law/rights, social factors such as recognition and certification of informal waste workers was threaded with concepts of solidarity while financial factors, aspects of social factors will be threaded with the concept of love. Space does not allow for full discussion of the process of reuse and recycling via informal waste workers, but this can be found in Chapter 6 of this thesis.

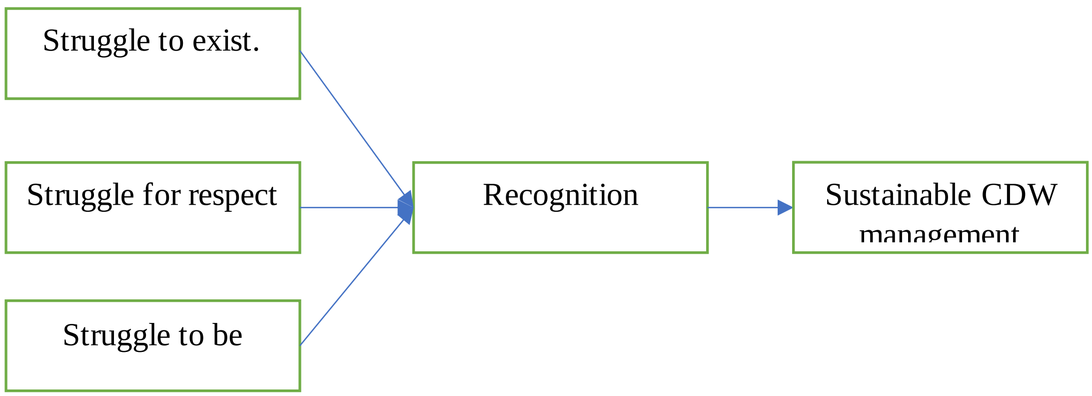

Figure 3.5: Struggle for recognition

3.4 Chapter Summary

This chapter addresses the research paradigm and the theoretical framework of the study. After considering the research onion and the metaphor of a glass box, the researcher chose the metaphor of a glass box to describe the research paradigm as the components are more widely applicable to this research work. The research paradigms considered are positivism, pragmatism, constructivism and interpretivism and each of these were further categorized by viewing their epistemology, ontology, and methodology. These assumptions and intellectual structures constituted the research and development in the field of enquiry.

The chapter included the step-by-step description of how the chosen research methods were applied, sources of data collection and the theoretical framework surrounding the study. The research methods applied included literature review, the Questionnaire, semi structured interviews, and ethnography by proxy(observation) methods. These methods assisted in answering the research questions and satisfied the research objectives. Positivism was employed earlier in the research with the use of questionnaires, later in the research, interpretivism was employed as interviews were held with politicians who have a stake in construction. Since both methods are required, pragmatism is the adopted approach for this research. Ethical issues regarding the protection of participants were also considered. This research work was approached in two phases: phase (1) the exploratory stage and phase (2) the explanatory phase. In phase (1), the results (survey and interview), which were more technically focused, were further analyzed using theory of planned behavior (TPB). This revealed that there was a deeper social focus which needed an alternative approach for phase 2. Hence, theory of recognition was chosen for further analysis of the third result chapter (ethnography), which becomes the phase 2 analysis.

Chapter 4 – PERCEPTION OF CONSTRUCTION STAKEHOLDERS

4.1 Introduction

This chapter discusses:

- Objective two - Analyze current practices relating to the reuse and recycling of CDW in Nigeria.
- Objective three - Investigate the barriers to the reuse and recycling of CDW in Nigeria.
- Objective four – Identify the drivers for effective CDW in Nigeria.
- Objective five - Evaluate the role of informal waste workers in the reuse and recycling of CDW in Nigeria.

Having described the research paradigm and justified the adopted philosophical stance and research strategy (Section 3.3), this section provides a comprehensive account of the findings derived from the analysis of the quantitative data obtained through the questionnaire. The questionnaire, as outlined in section 3.3, was distributed to a range of construction industry participants in Nigeria. Its purpose was to ascertain their perspectives on the significance of reuse/recycling, identify barriers to reuse/recycling, explore waste reduction strategies, investigate strategies supporting the reuse/recycling of CDW, examine waste management strategies, identify the causes of CDW, and assess the environmental and economic impacts of CDW. Further details regarding the structure and administration of the questionnaire can be found in the methodology chapter (Section 3.3.1). The results obtained from the questionnaire survey are presented below, followed by an examination of the limitations associated with the questionnaire's design and implementation.

4.2 Questionnaire Section 1: Background Information

4.2.1 Roles of participants (Professionals in the construction industry)

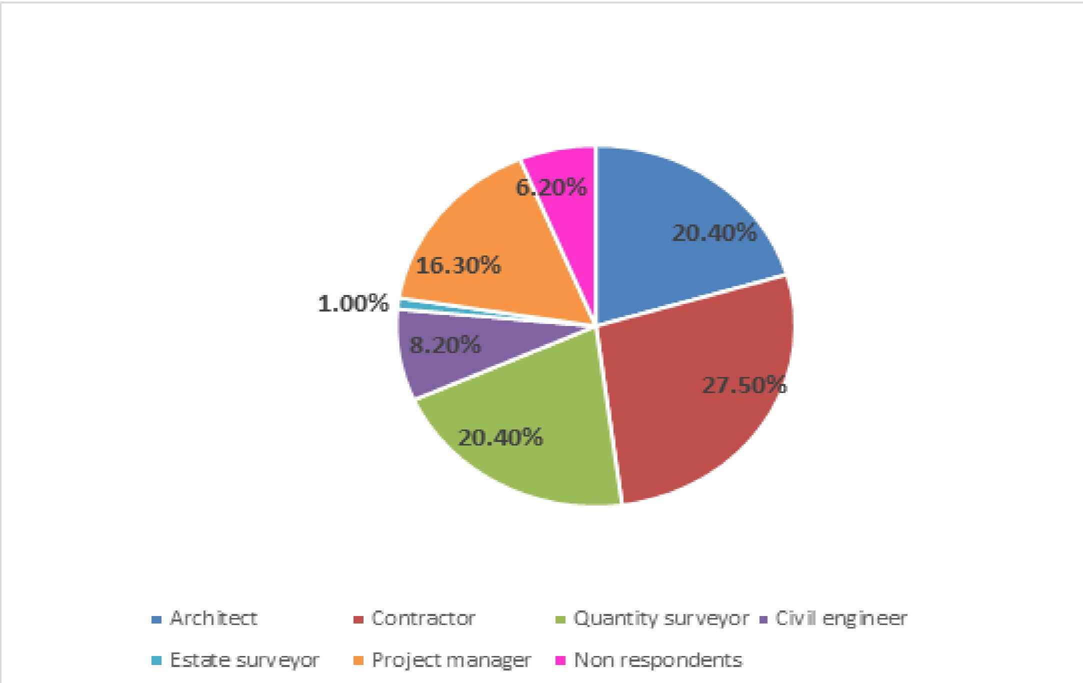

Figure 4.1: *Percentage of 98 participants by role****)***

Figure 4.1 showcases the positions held by the construction industry participants who took part in the survey. These individuals have decision-making roles within their organizations, which makes them well suited to understand the importance of CDW reuse and recycling. Based on the data it was found that contractors comprised 27.5% of the respondents followed by architects and quantity surveyors at 20.4% each. Project managers accounted for 16.3%, civil engineers for 8% and estate surveyors only made up 1%. This diverse mix ensures that views from professionals focused on design and construction are represented. It is worth mentioning that 6% of respondents did not disclose their positions, indicating that participation in the survey was voluntary and unbiased.

In developing countries like Nigeria, construction professionals often take on multiple roles (Ameh and Odusami 2014; Amaechi et al., 2022). Architects, for example, are typically responsible for tasks such as designing buildings, creating models and visualizations contributing to development plans well as serving as resident professionals at construction sites. They also play a role in supervising workers to ensure accurate implementation of architectural drawings.

Contractors on the other hand have a ranging role in the construction industry and the built environment. They oversee the bidding processes and execution of projects. Additionally, contractors collaborate with quantity surveyors and project managers on construction sites to ensure a supply of building materials. Quantity surveyors are responsible for tasks such as preparing bids bills of quantities and proposals within the construction industry (Ghisellini et al., 2018). Civil engineers play a role at construction sites by delegating responsibilities to other professionals. They collaborate with builders, masons, artisans, architects, and mechanical and electrical engineers. Estate surveyors handle tasks like land survey plans using GIS tools for site mapping and preparing land documents. Project managers are another profession in the construction industry who oversee project management activities including project schedule preparation and project delivery. All these professionals contribute collectively to aspects of CDW reuse and recycling, in Nigeria. Henceforth assessing their involvement is crucial as discussed in sections. Figure 4.1 represents percentage of the 98 construction industry participants by role.

4.2.2 Size of organization/ Number of employees

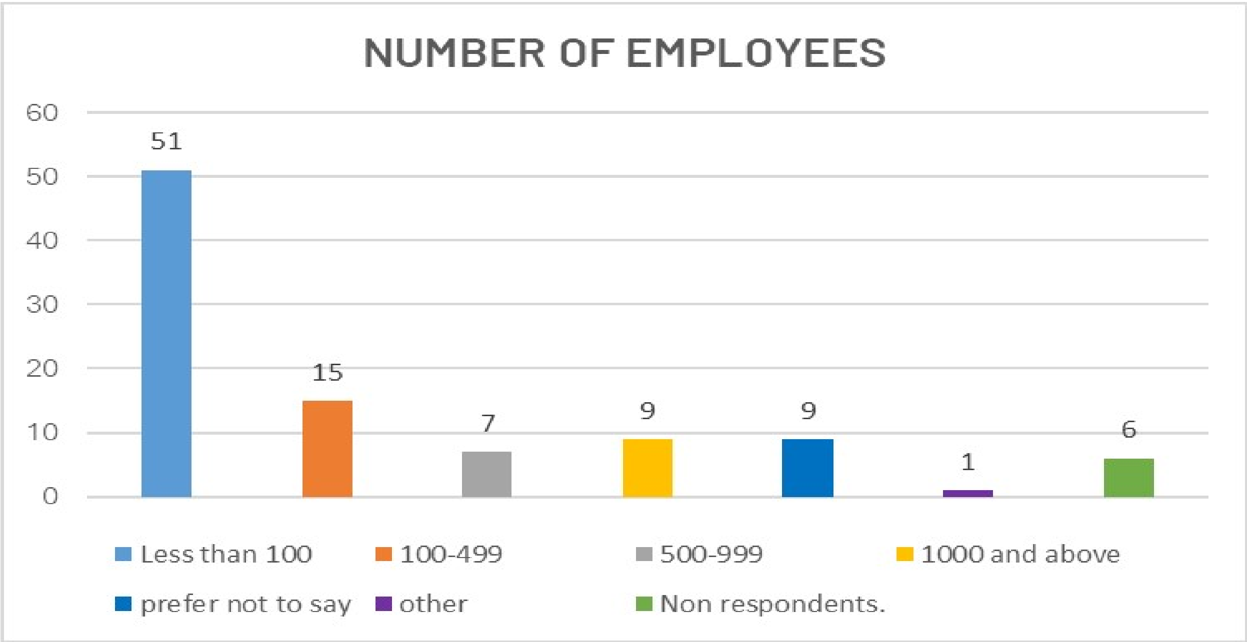

Figure. 4.2: Number of employees.

Figure 4.2 presents the breakdown of firm sizes in this study. Regarding the number of employees, 51 (52.1%) of the firms have less than 100 employees while about 15, being 15% have between 100 and 499 employees. 7 being (7.1%) of the firms have between 500 and 999 employees and 9 (9.2%) have over a thousand construction staff members. Additionally, 1 (1%) of companies that fall into size categories not specified in the question. Furthermore around 6, being 6% of participants chose not to provide an answer to this question.

The data shows that most responses (52.1%) come from small to medium-sized firms with less than a hundred employees. This indicates that most participants are affiliated with small to medium sized firms and aligns, with research discussed in Section 2.3.1, which emphasizes that Nigeria's construction industry is primarily composed of small and medium sized local companies (Wahab and Lawal 2011; Kaluarachchi, 2018).

Most construction companies in Nigeria are classified as small and medium enterprises (SMEs), with their workforce predominantly consisting of staff contracted for specific projects. Consequently, a company with a workforce of 100 individuals may only have 20% of them classified as permanent employees. However, when it comes to companies with more than 1000 employees they are mainly made up of multinational corporations, national companies, and a small number of privately owned businesses. It is worth noting that the classification of small and medium-sized companies in Nigeria is determined based on labor force and capital investment, and there is no widely agreed-upon consensus regarding their specific size parameters.

The summary of participants' responses to each demographic group is presented in Figure 4.3.

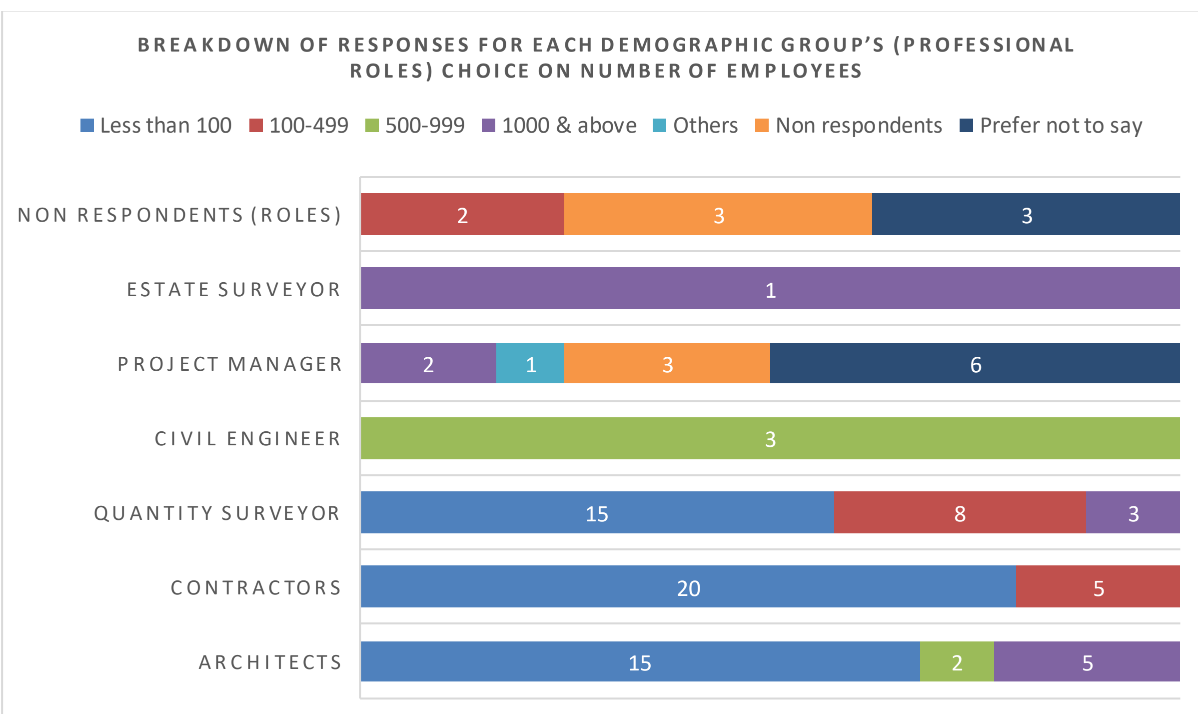

Figure.4.3 Breakdown of professional roles' choice on number of employees

The demographic groups were broken down into their constituent professional roles in Figure. 4.3. More than half of the participants (51) came from organizations with than 100 employees. This group consisted entirely of contractors (20), quantity surveyors (16) and architects (15). These findings align with the construction industry well. Figure 4.1 also suggests that civil engineers, project managers and estate surveyors are commonly associated with companies.

However, it is important to note that the field of construction requires a range of management talents and skills. Gaining these skills can only be accomplished through experience while acquiring knowledge necessitates learning in a stimulated environment (Ameh and Odusami 2014). Many small scales contracting construction firms in Nigeria primarily consist of artisans and craftsmen who may lack the necessary capacity enhanced employee productivity, digital transformation capabilities and crucial knowledge for effective construction waste management within the industry. Ezeokoli et al., (2016) Emphasized the need for collaboration between organizations and the Nigerian government to promote construction waste management. Since then, Han *et al.*, (2019) confirmed that the influence of demographic differences on CDW management has not fully been investigated. This investigation contributes to addressing this research gap.

4.3 Questionnaire Section 2: Awareness of Construction and Demolition Waste

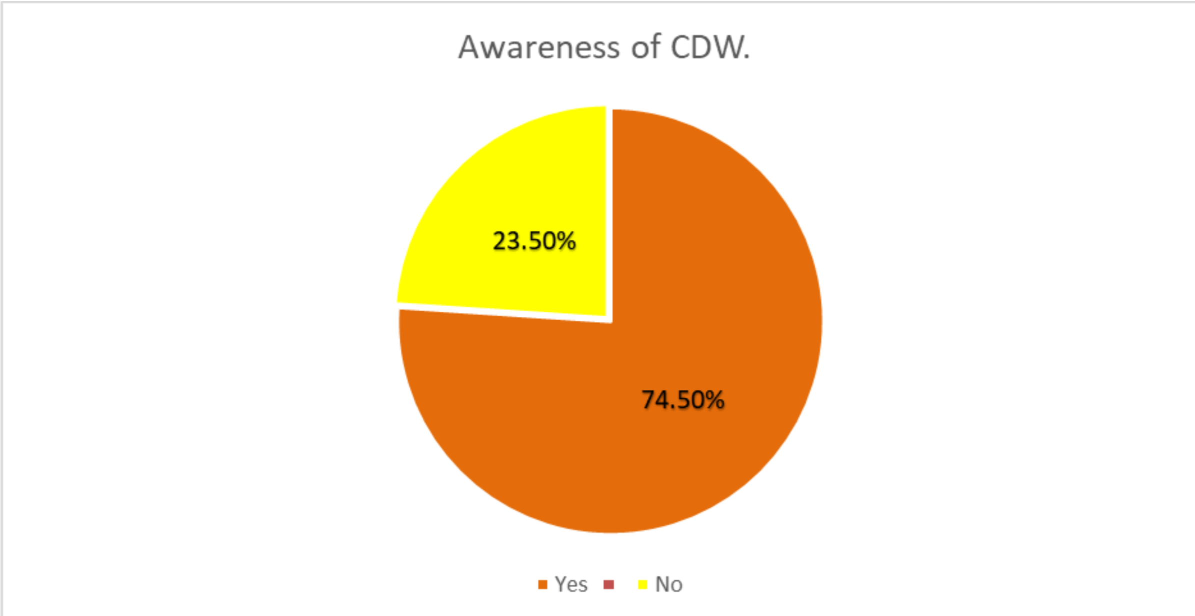

Figure 4.4 Awareness of CDW

Figure 4.4 presents the respondents' awareness of the quantity of CDW generated by their company. 73 being 74.5% of the participants indicated their awareness, while 23 (23.5%) stated that they are not aware of the CDW quantity produced by their company. Additionally, 2% of the participants did not provide information regarding their awareness status. These findings indicate that most participants understand the waste volume generated by their companies.

It is worth noting that the high level of awareness among participants may be attributed to a larger representation of respondents from small to medium-sized companies, rather than the availability of specific measuring tools to quantify the waste produced.

The analysis of each demographic group’s opinion on the awareness regarding the amount of CDW produced is presented in figure 4.5.

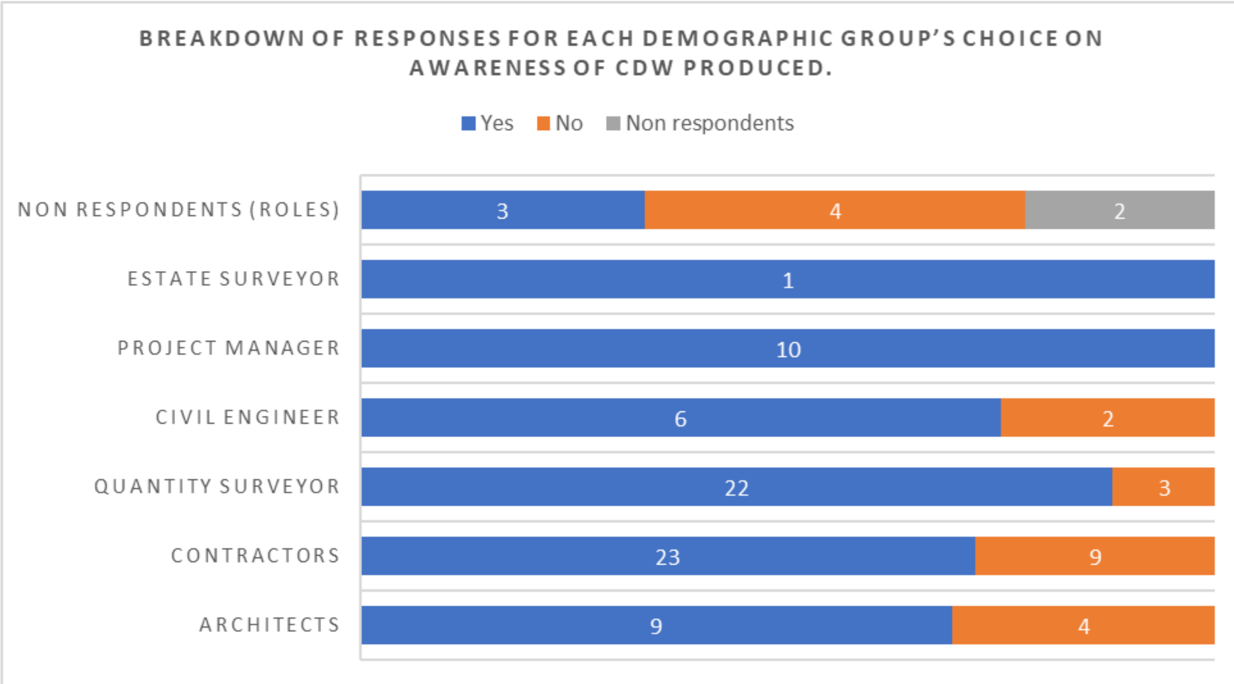

Figure.4.5 Breakdown of responses for each demographic group's choice on their awareness of CDW produced.

23 (30.1%) of "yes" responses were from contractors and 22 (29%) from Quantity surveyors. Indicating that these key roles generally possess a better understanding of the amount of CDW generated in their respective companies than the other responding roles. This is evidenced by relatively low proportions of "yes" responses from 10 project managers (13.2%), 9 architects (12%), 6 civil engineers (8%), 1 estate surveyor (1.3%), and 3 participants who did not specify their roles (4%).

Literature findings from Eze *et al.*, (2017) revealed that participants in the Nigerian construction industry tend to prioritize project goals such as cost and quality over minimizing the environmental impact of waste.

Concern about Amount of CDW generated:

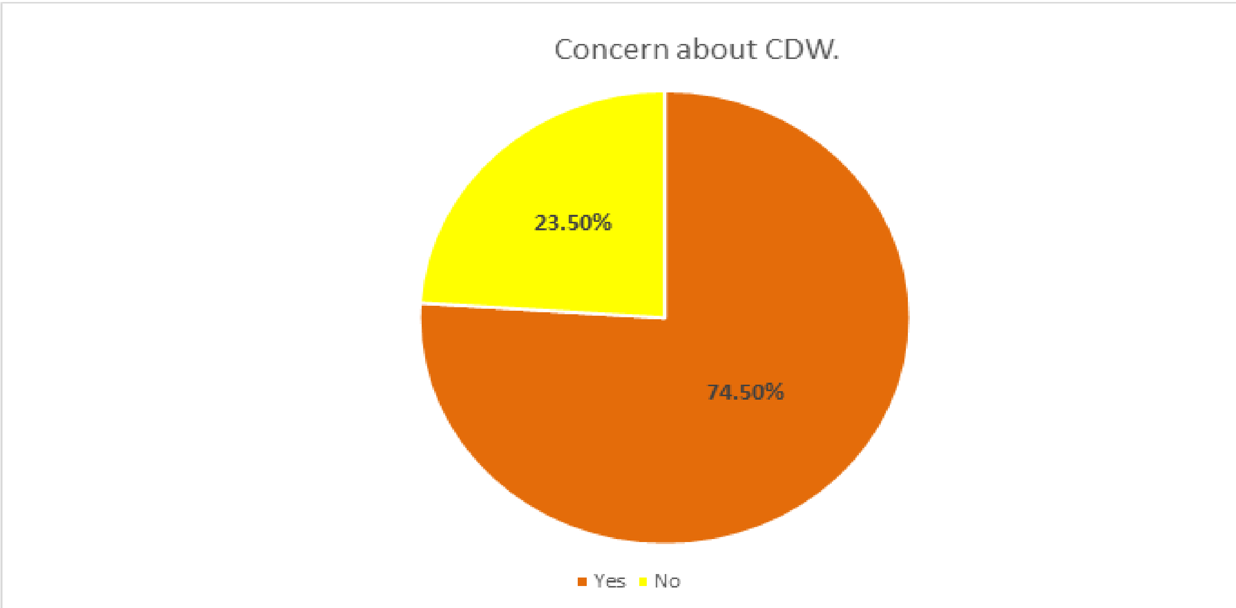

Figure 4.6 Concern about the amount the amount of CDW produced.

Figure 4.6 displays the level of concern among construction participants regarding the quantity of CDW generated by their company. A significant majority, 73 being 74.5% of the respondents expressed concern over the amount of CDW produced. Conversely, only 23 (23.5%) indicated no concern about the volume of CDW generated. It is worth noting that 2 (2%) of the participants did not provide a response to this question. These results suggest a potential willingness among participants to embrace change that promotes sustainable construction waste management practices in Nigeria.

Figure 4.7 is a breakdown of responses for each demographic group for concern about the amount of CDW produced.

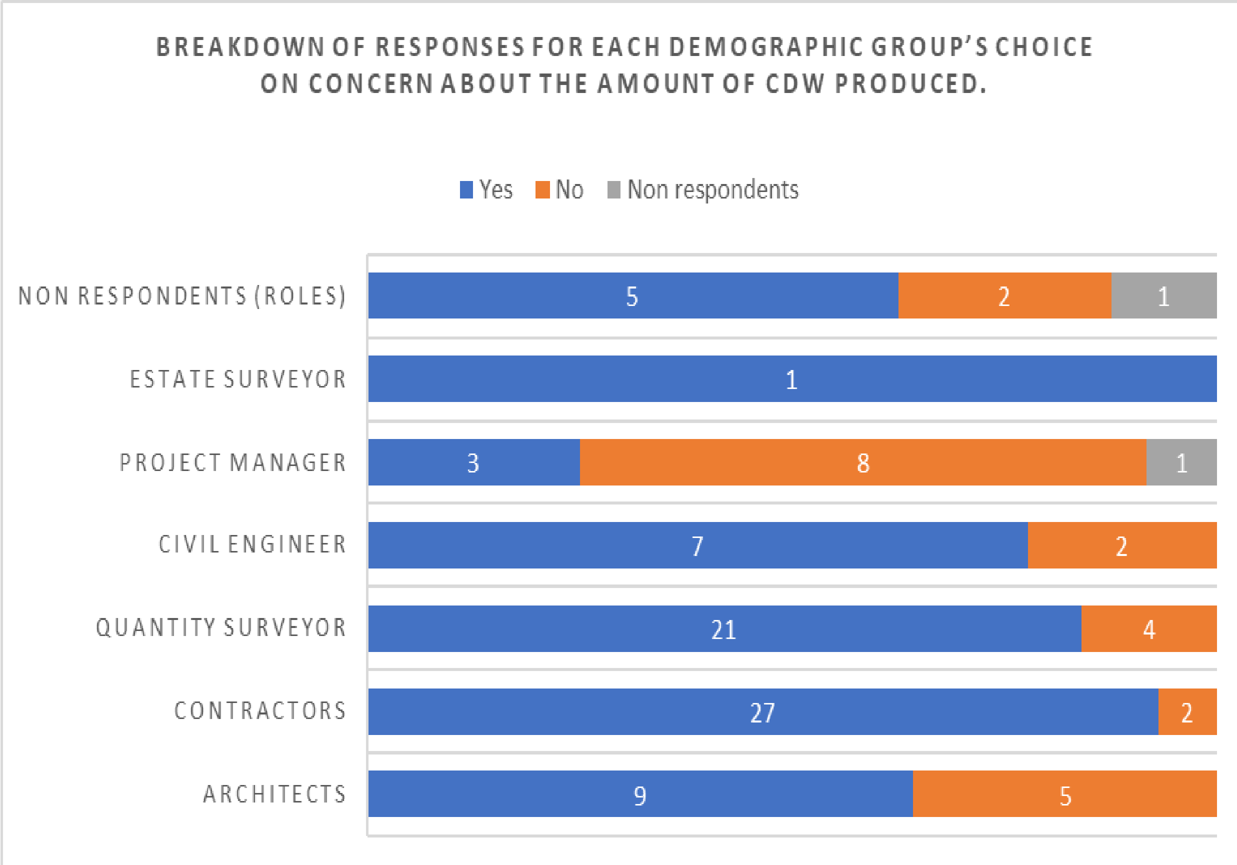

Figure. 4.7 breakdown of responses for each demographic group's choice for concern about the amount of CDW produced.

The two professions showing least concern about CDW created are 8 Project Managers (66.7% not concerned), and 5 architects (55.6%), are also two of the professions with less awareness of CDW created (see Figure. 4.5).

Does your company have a waste management plan?

***Figure. 4.8 Waste management plan*.**

Figure 4.8 illustrates the respondents' opinions regarding their companies' possession of a waste management plan. Among the 98 participants, 70 participants (70%) expressed the view that their company has a waste management plan, while 23 (23%) believed that their company does not have one. A small percentage of respondents (6.1%) being 6 participants did not provide a response to this question.

These findings indicate that most construction participants, particularly Civil Engineers, Quantity Surveyors, and Contractors, demonstrate an understanding of the impact of waste and have implemented waste management plans.

During a site visit in Nigeria (personal experience), a typical example was observed in a situation where a contractor and a client had an agreement. The agreement included a waste management plan that encompassed supplying emulsion paint for a building project and responsibly handling paint containers by retrieving and recycling them. Such a management plan not only proves to be cost-effective and sustainable but also reduces labor for the client.

Figure 4.9 is a Breakdown of responses for each demographic group for procession of waste management plan.

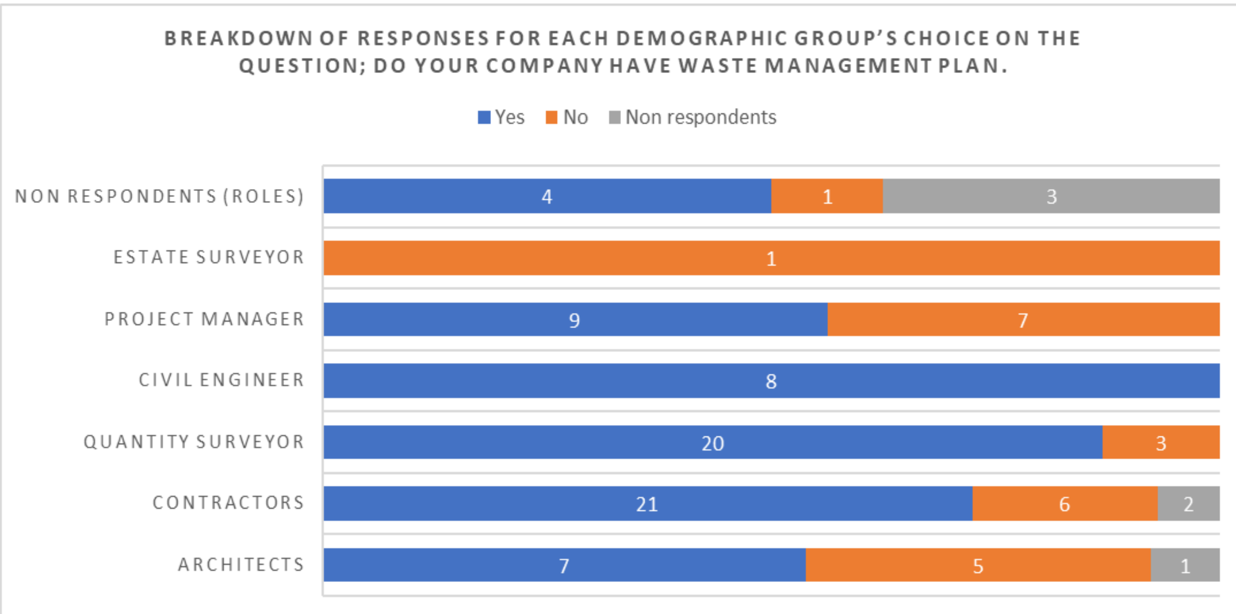

Figure 4.9 depicts the responses of professional roles regarding their possession of a waste management plan.

Most contractors (21) claim to have a waste management plan. It is important to note that this doesn't necessarily mean they have a waste management system in place. It simply suggests that they have a way to measure the amount of waste generated by their companies.

It is also worth mentioning that overall waste management practices in the Nigerian construction sector is generally considered inadequate (Dania, Kehinde and Bala, 2004; Brix-Asala, Hahn and Seuring, 2016).

Do you believe that reuse/recycling has the potential to manage substantial amount of CDW in the Nigerian construction industries?

Figure 4.10 illustrates respondents' beliefs regarding the potential of CDW reuse/recycling as a means of managing CDW in Nigeria.

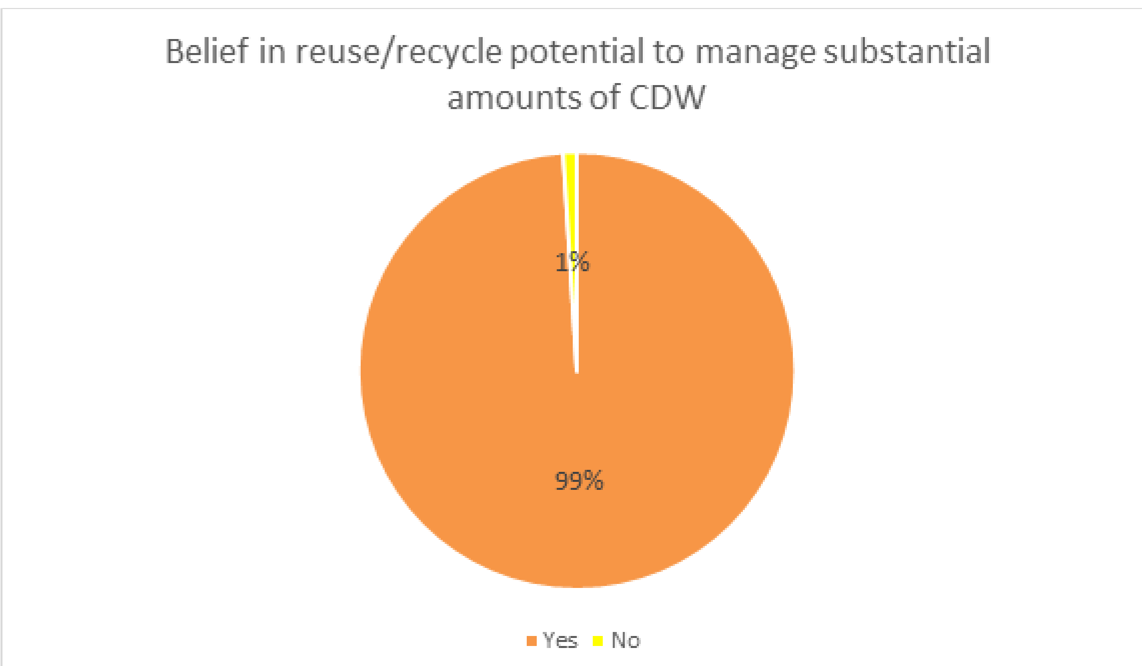

Figure 4.10: Belief in reuse/recycling potential to manage CDW in the Nigerian construction sector.

97, out of the 98 respondents (99%) believe that reusing and recycling can effectively manage a substantial amount of CDW in Nigeria while only 1(1%) disagreed. This is likely due to the widely adoption of informal reuse and recycling practices among construction workers in Nigeria.

However, this contradicts existing literature (Srivastava et al., 2012; Pathak et al., 2012; Mudashiru et al., 2016; Ogechukwu, 2020) which emphasizes the need for reuse and recycling practices, in Nigeria.

The recent recycling endeavors of Nigerian SMEs demonstrate their commitment to embracing waste reuse and recycling (Nwankpa, 2019). These SMEs are responsible for gathering waste from both dumping grounds and construction sites, with the aim of transforming redefining and repurposing it as CDW materials (Muriithi, 2017; Nwankpa, 2019).

It is worth noting that all the architects surveyed expressed a belief in the potential for reuse and recycling CDW. This could be because architects have a role in overseeing building design to ensure longevity and adaptability. They are also well positioned to select materials and components that can be easily dismantled and reused or recycled. Alongside prioritizing materials that are safe functional and visually appealing architects also can avoid using materials that cannot be reused or recycled in Nigeria. However, if such materials are deemed necessary by architects, it presents a chance for research to explore pathways for reusing or recycling them.

In your opinion, which of the following materials has the highest volume of wastage at the construction site?

Participants were requested to select one waste material out of a group of twelve options. The volume of waste generated by each material was accessed using five categories; major wasted, significantly wasted, minor wasted, insignificantly wasted, and never wasted.

Figure 4.11 illustrates the respondents' opinions regarding the extent of materials wastage observed on construction sites.

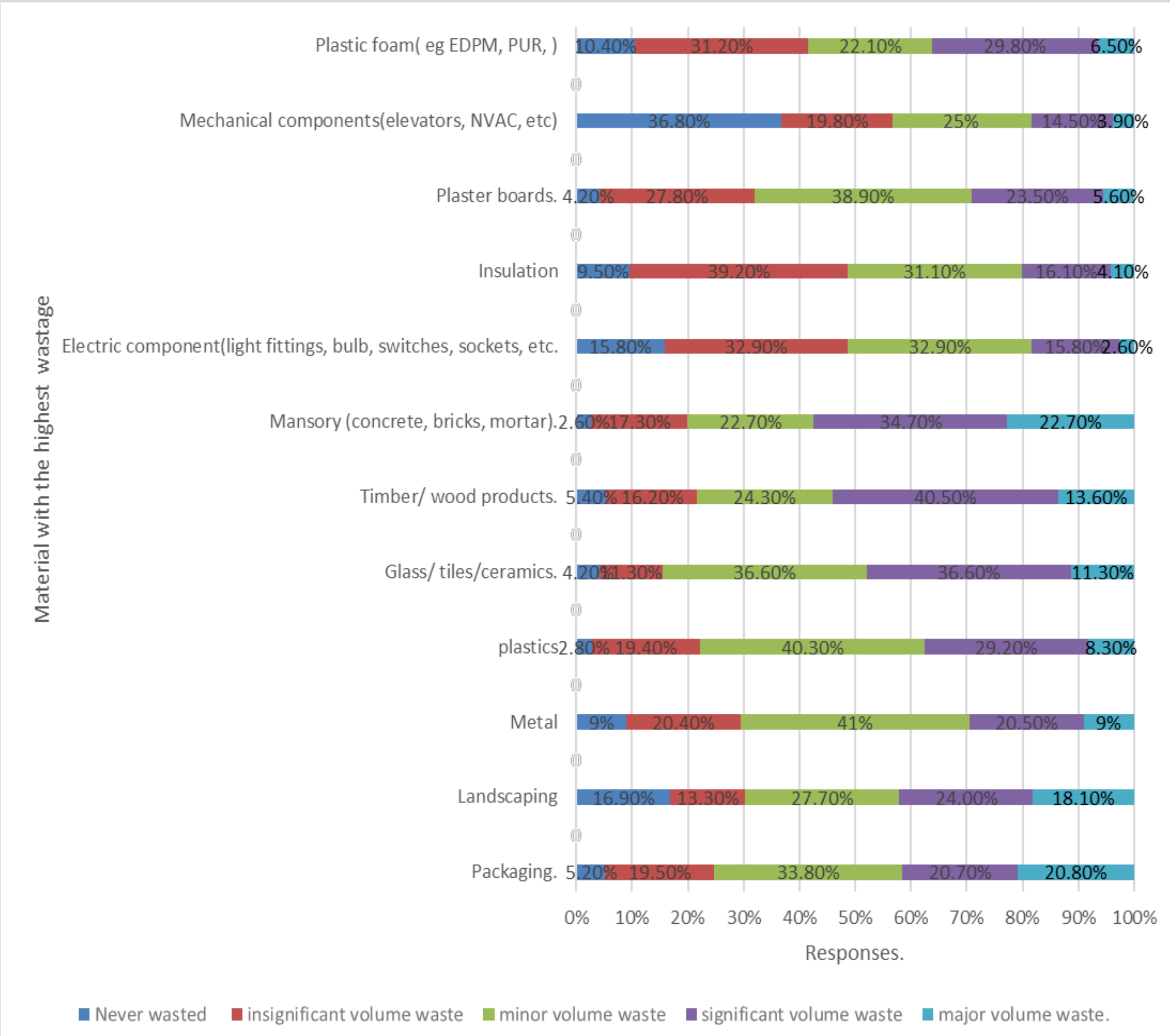

Figure 4.11: Material with highest volume of waste at the construction site

According to the responses, Mansory is considered the major contributor to waste volume at construction sites. Timber/wood products, glass/tiles/ceramics, landscaping, and packaging materials were also major contributors to waste volume. The lowest contributor to waste volume were Mechanical components and electric components, closely followed by insulation.

The respondents' perception that masonry is the most wasted material may stem from the prevalent use of blocks and mortar for house construction in Nigeria. However, Section 2.3.2 of the literature review reveals that the exact amount of CDW wastage in Nigeria remains unknown. This assertion aligns with a prior study, conducted by Moruff (2012), which confirms that solid waste in Nigeria comprises a mixture of both municipal and construction waste.

Table 4.1 records the data for specific professions.

Table 4.1: Breakdown of Professionals' view on materials with highest volume of waste at the construction site (summarized from Table 4.15 – 4.26 in Appendix E).

Waste from the following components	Architects	Contractors	Quantity Surveyor	Civil Engineer	Project Manager	Estate Surveyor	Non respondents (Roles)
Major wasted							
Packaging waste	2	5	3	2	2	0	2
Landscaping waste	1	7	3	2	0	0	2
Metal waste	1	2	2	1	0	0	0
Plastic waste	1	2	2	1	0	0	0
Glass waste	1	1	1	1	3	0	2
Timber waste	1	1	1	3	2	0	2
Insulation	0	2	0	0	1	0	0
Masonry waste	2	6	3	2	2	1	0
Electrical waste	0	1	0	0	1	0	0
Plaster waste	0	1	1	0	2	0	0
Mechanical waste	0	1	0	0	0	0	2

Plastic Foam	1	0	1	0	2	1	0
Significant waste							
Packaging waste	4	5	2	2	2	0	0
Landscaping waste	3	6	7	1	2	0	0
Metal waste	2	1	6	0	5	1	2
Plastic waste	2	5	6	0	5	1	2
Glass waste	4	8	8	2	2	1	0
Timber/wood waste	6	10	9	1	2	0	1
Masonry waste	3	9	7	1	4	0	2
Electrical waste	5	1	2	0	1	1	2
Insulation	2	2	3	2	1	0	2
Plaster	6	6	0	1	3	0	1
Mechanical waste	2	3	2	2	1	1	0
Minor waste							
Packaging waste	3	7	8	2	4	1	1
Landscaping waste	2	8	7	0	4	1	1
Metal waste	2	4	9	1	4	0	1
Plastic waste	6	10	5	3	4	0	1
Glass waste	3	9	8	1	4	0	1

Timber/wood waste	0	5	9	1	2	0	0
Masonry waste	2	4	7	1	3	0	0
Electrical waste	0	11	5	1	7	0	0
Insulation	1	9	2	0	3	1	0
Plaster waste	3	7	12	0	4	1	0
Mechanical waste	3	6	4	1	4	0	0
Plastic Foam	3	8	4	0	2	0	0
Insignificant wasted							
Packaging waste	1	4	6	0	4	0	0
Landscaping waste	2	3	3	1	2	0	0
Metal waste	2	4	6	0	3	0	0
Plastic waste	2	1	9	1	0	0	1
Glass waste	0	1	5	0	2	0	0
Timber/wood waste	2	4	3	1	2	0	0
Masonry waste	2	2	4	2	3	0	0
Electrical waste	3	5	11	4	1	0	1
Insulation	4	6	9	3	1	0	1
Plaster	2	5	6	4	1	0	0

Mechanical waste	2	4	7	1	1	0	0
Plastic Foam	2	4	12	2	2	0	1
Never Wasted							
Packaging waste	0	0	0	2	2	0	0
Landscaping waste	4	0	2	3	5	0	0
Metal waste	0	3	0	2	1	1	0
Plastic waste	0	1	0	1	0	0	0
Glass waster	0	1	0	2	0	0	0
Timber/wood waste	2	0	0	0	1	1	0
Masonry waste	1	1	0	0	0	0	0
Electrical waste	3	2	3	1	2	0	1
Insulation	0	1	5	0	1	0	0
Plaster	0	1	2	0	0	0	0
Mechanical	3	9	9	2	4	0	1
Plastic Foam	2	3	2	1	0	0	0

The views of individual professions with regards to materials with highest volume of waste were presented in Table 4.1 (summarized from Table 4.15 – 4.26 in Appendix E). Aggregation of major and significantly wasted material saw most contractors (15) identifying Masonry as constituting the highest volume of wastage at construction sites in Nigeria.

4.4 Questionnaire Section 3: Causes/Sources of Waste

The following are possible causes of CDW waste. In your opinion, please rank them:

Respondents' opinions on the potential causes of waste were analyzed and presented in Figure 4.12.

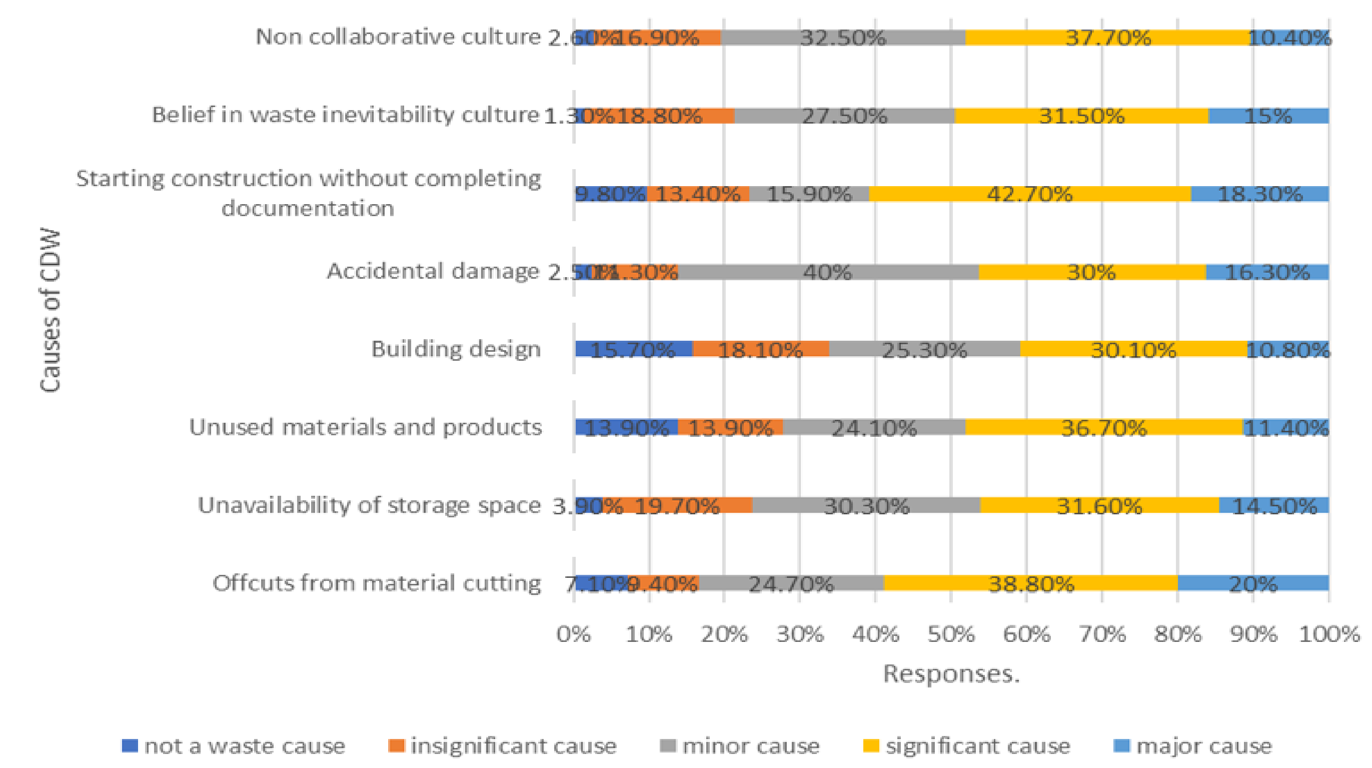

Figure 4.12: Causes of waste.

The questionnaire presented eight established causes of waste at construction sites, and participants were asked to rate them on a scale of 1 (not a waste cause) to 5 (major cause). For analysis, in relation to each profession, major and significant causes were aggregated. The results were presented in Table 4.2.

The results revealed that 60 (61%) of the 98 construction participants who responded believed that commencing construction without completing documentation was a major cause of waste. This finding is particularly interesting since addressing this issue requires changes in practices rather than the implementation of new infrastructure.

The second most significant cause of waste, according to 58 (58.8%) of the respondents, was the generation of offcuts during material cutting. When there is an increased demand for a particular product that necessitates material cutting, the quantity of offcuts produced also increases. For example, offcuts from aluminum profiles are commonly observed.

The third causes identified by respondents were a "non-collaborative culture" and "unused materials and products," each selected by 47 (48.1%) of participants.

In Nigeria, many materials arrive in large quantities, leading to a surplus of unused materials like bricks (48.1%). Project managers may incur costs for mobilizing, transporting and renegotiating these surplus materials. As a result, it can sometimes be more cost effective to dispose of them as construction waste.

The idea of a "waste inevitability culture" cited by 46 participants (46.5%) ranks high among construction participants in Nigeria. Many believe that waste is a part of the process and therefore don't pay attention to minimizing it.

Accidental damage, cited by 45 participants (46.3%) is another contributor to waste, during transportation and storage stages. Materials such as floor tiles, wall tiles, PVC composite materials, taps and WC components are prone to cracks or breakages during these phases.

Insufficient storage space cited by 45 participants (46.1%) can also lead to wastage. When there are not enough storage capacity less desirable construction materials may be discarded, resulting in unnecessary waste.

Lastly the design of buildings, cited by 40 participants (40.9%) also plays a role in generating waste.

By incorporating material sizes into the design of buildings, such as using glazing panes that align with manufactured dimensions (whole, half, third, etc.) architects can minimize wastage by reducing offcuts. However only a handful of architects and designers actively embrace this approach.

Considering the observations above, causes of waste can be classified into two categories; tangible factors associated with the materials themselves and intangible factors linked to working practices and industry beliefs. Tangible causes include offcuts generated during material cutting, unused materials and products accidental damage building design considerations and limited availability of storage space.

Table 4.2 represents a breakdown of a Professional's view on different causes of waste (extracted from Table 4.27-4.34 in appendix E). The abbreviations adopted are: The abbreviations used are: Non collaborative culture (NCC), Belief in waste inevitability culture (WIC), starting construction without complete documentation (ID), Accidental damage (AD), building design (BD), Unused materials and products (UMP), Unavailability of storage space (USS), offcuts from material cutting (OMC).

Table 4.2 Breakdown of Professional's view on causes of waste

(extracted from Table 4.27-4.34 in appendix E).

Waste Components (Abbreviated)	Architects	Contractors	Quantity Surveyor	Civil Engineer	Project Manager	Estate Surveyor	Non respondents (Roles)
Major cause							
NCC	1	2	3	0	2	0	0
WIC	1	0	3	0	2	0	0
ID	1	4	4	2	3	0	2
AD	0	5	2	1	5	0	2
BD	0	2	2	3	2	0	0
UMP	1	1	5	0	2	0	0
USS	1	3	2	1	3	0	1
OMC	1	5	6	1	1	0	2
Significant cause							
NCC	4	11	11	1	0	0	2
WIC	4	11	11	2	4	0	0
ID	5	17	9	1	4	0	0
AD	2	10	6	0	3	1	0
BD	2	10	6	0	3	1	0
UMP	3	11	8	1	4	0	2
USS	4	7	11	1	1	0	0
OMC	7	10	9	2	5	0	1
Minor cause							
NCC	2	8	7	1	6	1	0
WIC	5	5	7	0	1	1	3

ID	2	2	6	1	2	0	0
AD	8	8	12	2	2	0	0
BD	5	8	7	0	3	1	2
UMP	6	0	5	0	1	1	0
USS	3	6	7	1	4	0	2
OMC	2	11	3	1	4	0	0
Insignificant waste							
NCC	4	0	1	3	4	0	1
WIC	2	2	2	4	4	0	0
ID	4	1	1	1	3	0	1
AD	1	1	2	2	2	0	1
BD	3	4	2	2	3	0	1
UMP	0	2	3	4	2	0	0
USS	3	7	2	2	2	0	0
OMC	2	1	3	1	1	0	0
Not a waste cause							
NCC	1	1	1	3	4	0	0
WIC	0	1	0	0	0	0	0
ID	2	1	2	0	2	1	0
AD	1	0	0	0	1	0	0
BD	2	2	6	1	2	0	0
UMP	3	4	1	0	2	1	0
USS	0	1	0	0	0	1	0
OMC	0	1	2	1	2	1	0

The causes of waste in the Nigerian construction industry were discussed by participating construction professionals and the findings are summarized in Table 4.2 (based on information from Table 4.27- 4.34 in Appendix E).

Observing the figures above revealed that most contractors (21) identified starting construction without complete documentation as a significant factor. Interestingly both contractors and quantity surveyors had high vote counts across all segments for causes while architects had relatively lower percentages in comparison.

4.5 Questionnaire Section 4: Waste Reduction Strategies

Which of the following waste reduction strategies has your company applied in your recent projects?

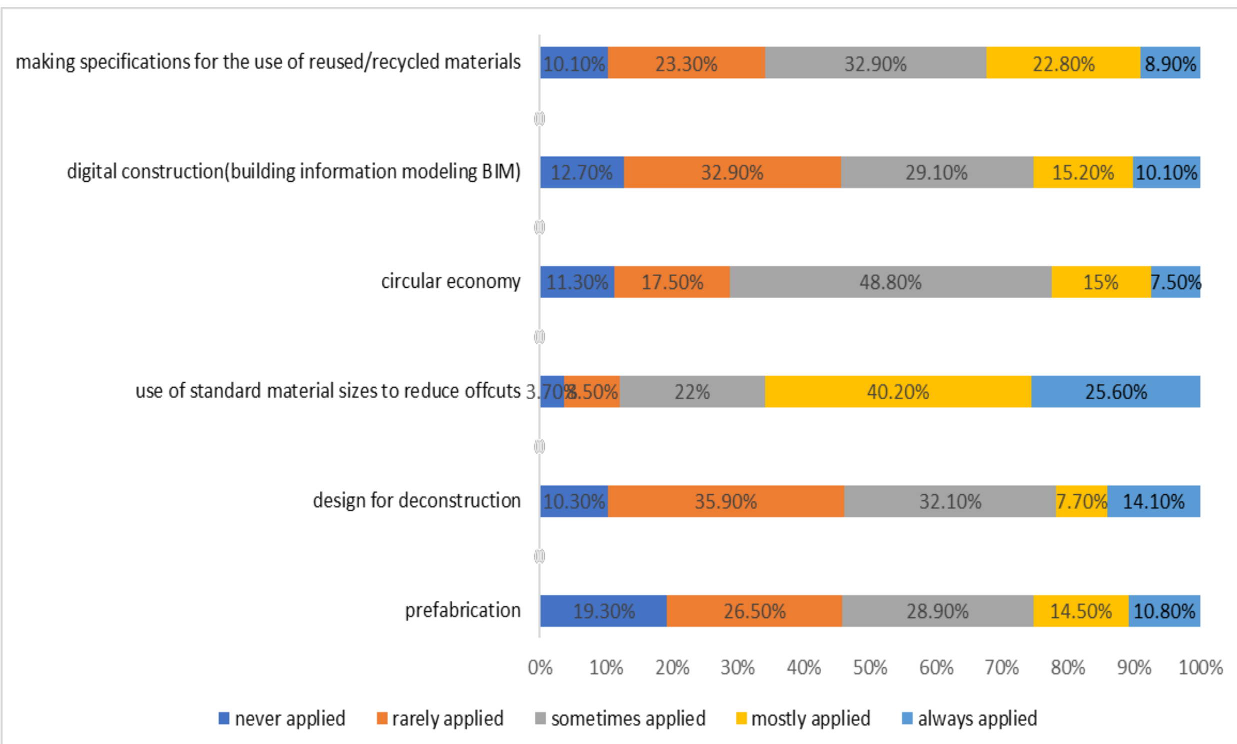

Figure.4.13: Waste reduction strategy

Figure 4.13 displays the opinions of respondents regarding waste reduction strategies on construction sites. The survey presented six strategies; prefabrication, design for deconstruction using standard material sizes to minimize waste, circular economy principles, digital construction methods and specifying the use of reuse/recycled materials. Participants rated these strategies on a Likert scale from 1, to 5 (ranging from never applied to applied). The strategy that received the percentage for being mostly or always applied was using standard material sizes to reduce waste (65.8%), supported by 64 participants. This was followed by specifying the use of recycled materials (31.7%), supported by 31 participants, digital construction (BIM) and prefabrication (25.3% each), supported by 25 participants each, circular economy principles (22.5%), supported by 22 participants and lastly design for deconstruction (21.8%), supported by 21 participants. Considering that a significant portion of construction costs is related to materials, it has become increasingly important to manage them to reduce expenses, given Nigeria's current economic downturn (Eze et al., 2020). The knowledge transfer of best practices within the Nigerian construction and manufacturing industries is primarily carried out from the construction firm's owner to their staff, artisans, technicians, interns, and helpers.

In Nigeria the unskilled workers who assist workers are commonly referred to as laborers or helpers. These individuals help with tasks, like cement mixing for masons and unloading cement bags from the site store. Within the construction industry knowledge transfer is also prevalent among the Igbo tribe through apprenticeships. Recent studies conducted by Harvard (Ejo orusa Henry, 2019; Ekekwe, 2021) have recognized this form of knowledge transfer as an important aspect. Many individuals in the labor force who undergo apprenticeships may not have education from institutions, but they gain trade skills and receive on the job training instead. Their understanding of standard materials is primarily based on experience rather than relying on international or national standards like the Nigerian Industrial Standard (NIS) from Standard Organization of Nigeria (SON) British Standard Institution (BSI) or International Organization, for Standardization (ISO).

Moreover, literature findings on similar processes were discussed in Section 2.2.3.6. These findings revealed that prefabrication can lead to approximately 90% waste reduction. Currently, the Nigerian construction industry relies on industry standards and specifications (Egwunatum *et al.*, 2022). However, there is currently no standard that specifically covers CDW materials. This study recommends the incorporation of CDW in NIS standards. Additionally, increased use of local materials has been proposed previously in Nigeria (Ekekwe, 2021), and this has potential for supporting CDW reuse because they bare sustainable as natural materials typically last longer and better withstands everyday wear and tear than their manmade counterparts. It also helps to cut down on transportation related carbon emissions in the environment (Zhang *et al.*, 2020).

Table 4.3 is a breakdown of responses for each demographic group's (professional roles) choice on the question - Waste reduction strategies.

The waste reduction strategies are prefabrication, design for deconstruction, use of standard material sizes to reduce offcuts, circular economy, digital construction and making specifications for reuse/recycled materials (Reuse/Recycle).

Table 4.3: Professional view on different waste reduction strategies (extracted from Table 4.35-4.40 in appendix E).

Waste Components	Architects	Contractors	Quantity Surveyor	Civil Engineer	Project Manager	Estate Surveyor	Non respondents (Roles)
Always applied							
Prefabrication	1	1	4	1	2	0	1
Design for Deconstruction	2	3	3	1	2	0	0
Standard sizes	3	6	7	2	2	0	0
Circular economy	1	1	4	1	2	0	1
Digital Construction	0	1	4	2	1	0	0
Reuse/Recycle	0	2	4	0	0	1	0
Mostly applied							
Prefabrication	0	5	5	0	2	1	2
Design for Deconstruction	0	2	2	0	1	0	3
Standard sizes	6	7	9	1	7	0	0
Circular economy	0	5	5	0	2	1	2
Digital Construction	2	2	2	0	5	0	1
Reuse/Recycle	3	5	5	1	4	0	0
Sometimes applied							
Prefabrication	3	7	6	2	2	0	0
Design for Deconstruction	2	11	7	1	2	1	0
Standard sizes	2	8	7	1	1	1	3
Circular economy	0	12	11	2	6	0	2

Digital Construction	4	11	8	0	0	0	0
Reuse/Recycle	4	8	6	0	5	0	3
Rarely applied							
Prefabrication	2	10	5	2	3	0	0
Design for Deconstruction	7	6	9	3	4	0	0
Standard sizes	1	4	0	1	1	0	0
Circular economy	3	4	4	1	2	0	0
Digital Construction	3	7	6	3	6	0	2
Reuse/Recycle	4	3	6	4	3	0	0
Never Applied							
Prefabrication	6	4	3	1	3	0	0
Design for Deconstruction	2	3	1	0	1	0	0
Standard sizes	2	0	0	0	1	0	0
Circular economy	0	4	1	1	3	1	0
Digital Construction	3	3	3	0	0	1	0
Reuse/Recycle	1	4	2	0	1	0	0

Table 4.3 is a summary of the professionals' preferences for waste reduction strategies (based on data from Tables 4.41 4.49 in Appendix E). To provide an evaluation we aggregated the waste reduction strategies that professionals always or mostly apply within each category.

When we combined the waste reduction strategies that are always practiced or mostly practiced, a total of 16 votes were found. This was the number of votes among quantity surveyors who primarily rely on using material sizes as their preferred waste reduction strategy. On the hand architects and contractors had lower votes, across all categories for their always and mostly applied waste reduction strategies.

4.6 Questionnaire Section 5: Drivers to Reuse and Recycling

Ranking the Drivers for Reuse/Recycling of CDW

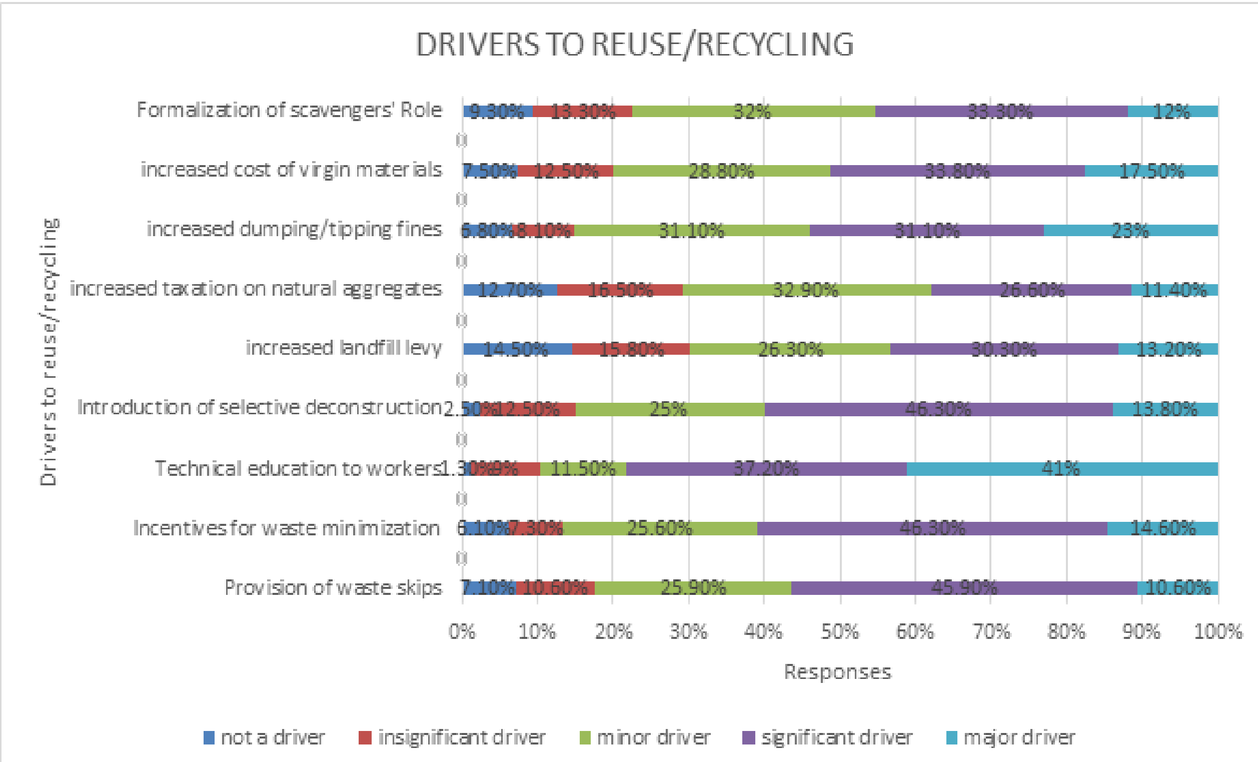

Figure.4.14: Drivers to reuse/recycling.

Figure 4.14 illustrates respondents’ opinions regarding nine factors that contribute to reuse and recycling in Nigeria. They were asked to rate these factors on a scale of 1-5 ranging from "not a factor”, to "major factor." Combining the significant and major drivers from Figure 4.14, the following rankings emerged: providing technical education to construction workers (considered a social driver) emerged as the top driver with, supported by 77 participants (78.2%). It was closely followed by providing incentives for waste minimization (a financial driver), supported by 60 participants, with a percentage of 60.9%. Other notable drivers included the introduction of deconstruction (considered a technical driver), supported by 59 participants at 60.1%. Provision of waste skips (also considered a technical driver), supported by 55 participants at 56.5%, increased dump/tipping fines (a financial driver), supported by 53 participants at 54.1%, increased cost of virgin materials (another financial driver), supported by 50 participants at 51.3%, formalization of scavengers role (a social driver), supported by 44 participants at 45.3%, increased landfill levy (yet another financial driver), supported by 43 participants at 43.5% and increased taxation on natural aggregates (also classified as a financial driver), supported by 37 participants ranking last at 38%.

The finding that technical education is seen as a driving force can be attributed to the scarcity of technical colleges and other similar institutions, in Nigeria.

In the city of Aba there is a need for rehabilitation, renovation, and rebranding in colleges. It is crucial for the government to investigate the condition of colleges in Nigeria as professionals and skilled workers require training to tackle waste management challenges. Although Nigeria has a pool of manpower youth unemployment remains one of the obstacles to national development. To address this issue, it is important to establish repositories that focus on vocational education (Salabson, 2019).

As mentioned in Section 4.4 the Nigerian construction workforce heavily relies on knowledge transfer than formal training (Ejo orusa Henry, 2019; Ekekwe, 2021). Additionally, as previously suggested in Section 4.5 CDW (Construction and Demolition Waste) is not considered in NIS (National Industrial Standard) (Ekekwe, 2021).

Another aspect to consider is the formalization of scavenger's roles. Although this is ranked lower among drivers it still received support from 50% of participants.

There are three measures that are seen as beneficial: providing incentives for waste minimization, increasing penalties for dumping/tipping waste and raising the cost of new/virgin materials. However, determining who should receive these incentives raises a question.

Selective deconstruction and the provision of waste skips are the only proposed technical drivers, and both have shown to be strong motivators (Poon *et al.*, 2004; Silva, de Brito and Dhir, 2017a).

Table 4.4 (summarized from Table 4.41-4.49 in Appendix E) is a breakdown of participants (different Roles's) view on drivers to reuse and recycling in Nigeria.

Table 4.4: Breakdown of Professionals' view on different drivers to Reuse/Recycle

Waste Components (Abbreviated)	Architects	Contractors	Quantity Surveyor	Civil Engineer	Project Manager	Estate Surveyor	Non respondents (Roles)
Major driver							
Use of waste skips	1	0	5	1	2	0	0
Incentives	2	4	2	2	1	1	0
Tech. Education	2	9	10	3	4	0	1
Deconstruction	2	2	4	1	1	0	1
Landfill levy	0	4	2	0	2	0	2
Taxation	1	3	3	0	2	0	0
Dumping fines	2	5	6	1	1	0	2
Increased cost of virgin material	4	4	1	1	1	0	3
Formalizing scavenger role	2	4	1	1	0	0	1
Significant driver							
Use of waste skips	5	12	13	2	3	0	0
Incentives	5	10	10	3	8	0	2
Tech. Education	9	9	8	2	5	1	1
Deconstruction	4	16	11	2	3	0	1

Landfill levy	3	11	6	1	0	0	2
Taxation	1	5	7	2	4	0	2
Dumping fines	3	10	6	1	3	0	0
Increased cost of virgin material	2	9	8	1	6	0	1
Formalizing scavenger role	4	8	9	1	0	0	0
Minor driver							
Use of waste skips	3	7	4	2	5	1	0
Incentives	3	7	5	1	3	0	2
Tech. Education	3	2	2	1	1	0	0
Deconstruction	4	4	6	1	3	0	2
Landfill levy	3	5	5	2	5	0	0
Taxation	6	8	5	2	3	0	2
Dumping fines	3	6	6	1	4	1	2
Increased cost of virgin material	5	7	6	1	4	0	0
Formalizing scavenger role	5	7	7	1	3	0	1
Insignificant driver							
Use of waste skips	2	4	1	0	2	0	0
Incentives	2	2	1	0	1	0	0
Tech. Education	2	3	0	0	2	0	0
Deconstruction	2	1	1	1	5	0	0
Landfill levy	4	1	1	2	3	1	0
Taxation	6	8	3	1	3	1	0
Dumping fines	2	0	0	1	3	0	0
Increased cost of virgin material	1	2	3	2	2	0	0
Formalizing scavenger role	1	0	1	2	4	0	2
Not a driver							
Use of waste skips	1	1	0	1	3	0	4
Incentives	1	1	0	1	3	0	4
Tech. Education	0	0	1	0	0	0	0
Deconstruction	0	1	0	0	0	1	0

Landfill levy	1	1	1	0	2	0	0
Taxation	3	1	4	1	1	0	0
Dumping fines	1	0	3	1	0	0	0
Increased cost of virgin material	0	0	4	1	0	1	0
Formalizing scavenger role	0	2	3	0	1	1	0

For analysis, in relation to drivers to reuse/recycling, major and significant drivers were aggregated. The results were presented in Table 4.4 (summarized from Table 4.41-4.49 in Appendix E). Aggregating major and significant drivers to reuse/recycling saw most quantity surveyors (18) identifying the use of waste skips as the major driver to reuse/recycling.

Overall, the votes from contractors and quantity surveyors were the strongest, while the remaining groups had lower participation. Therefore, the use of waste skips could be considered the major driver for reuse/recycle in Nigeria.

Are you aware that informal waste pickers (Scavengers) can act as possible means of reuse/recycling of CDW in Nigeria?

Table 4.5: Awareness of informal waste pickers as possible means of reuse/recycling.

Are you aware that informal waste pickers (Scavengers) can act as possible means of reuse/recycling of CDW in Nigeria?	Responses	Percentage
I am aware of waste pickers (scavengers) and believe that they recover substantial amount of recyclable and reusable materials	51	52.0%
I am aware of waste pickers (scavengers) but believe that they are not an efficient solution	31	31.6%
I am aware of waste pickers (scavengers) but believe that they are a problem	5	5.1%
I am not aware of waste pickers (scavengers)	6	6.1%
Other	1	1.0%
Non respondents	4	4.1%
Total	98	100.%

Table 4.5 shows respondents' awareness of informal waste pickers (scavengers) acting as potential means of CDW reuse/recycling. 51 participants (52%) agreed that they are aware of waste pickers (scavengers) and believe that they are an efficient solution. Another 31 participants (31.6%) are aware of scavengers' existence but do not believe they are an efficient solution. A further 5 participants (5%) acknowledged the awareness of waste pickers (scavengers) but believe that they are a problem. Only 6 participants (6.1%) were not aware of waste pickers (scavengers) acting as possible means of reuse/recycling at all, while 4 participants (4%) did not respond to the question. Most of the population being aware of the importance of informal waste pickers in CDW reuse/recycling supports the findings from earlier studies (Amadi and Chijioke, 2018; Hartmann,

2018) that scavengers are considered an effective way of managing waste in Nigeria. Scavengers are already operational in most Nigerian cities, and it is likely that the contractors (who constitute most of the respondents in Table 4.1) often trade their CDW with the scavengers, thus affirming their role as possible means of CDW reuse/recycling. This also aligns with the literature findings in Section 2.3.3, which indicate that a significant portion of waste management responsibilities is carried out by private builders and clients who derive earnings from reusable waste materials. Based on the amount of CDW recovered by scavengers, some municipalities in Port Harcourt city of Rivers State, Nigeria, have reported a plan to integrate scavengers as a lucrative outlet for waste (Amadi and Chijioke, 2018).

31participants are aware of scavengers but do not believe they are an efficient solution. This could be a contributing factor to the lack of support for the formalization of scavengers' role in driving reuse and recycling in Nigeria, as depicted in Figure 4.14. Furthermore, scavengers may not receive adequate education on state-of-the-art practices in the industry concerning reuse/recycling. 5 participants believe that scavengers are problematic. This perception might stem from the fact that some scavengers engage in dishonest practices and lack moral values and professional ethics. Some scavengers resort to stealing construction materials and CDW from construction sites, households, and other locations. However, such improper practices are strongly condemned and discouraged in the Nigerian construction industry and by the Scavengers Association of Nigeria (SAN) (Sesan, 2018). This might be part of the reasons why some scavengers' associations in Lagos were disbanded by the Lagos State government (Sesan, 2018). These findings substantiate the literature findings in Sections 2.2.6.2 and 2.3.1, which indicate that scavengers are vulnerable and seen as a problem by certain segments of the Nigerian population (Kashyap and Visvanathan, 2014; Amadi and Chijioke, 2018).

Figure 4.15 is a breakdown of responses for each demographic group's choice on awareness of waste pickers as possible means of reuse /recycling of CDW

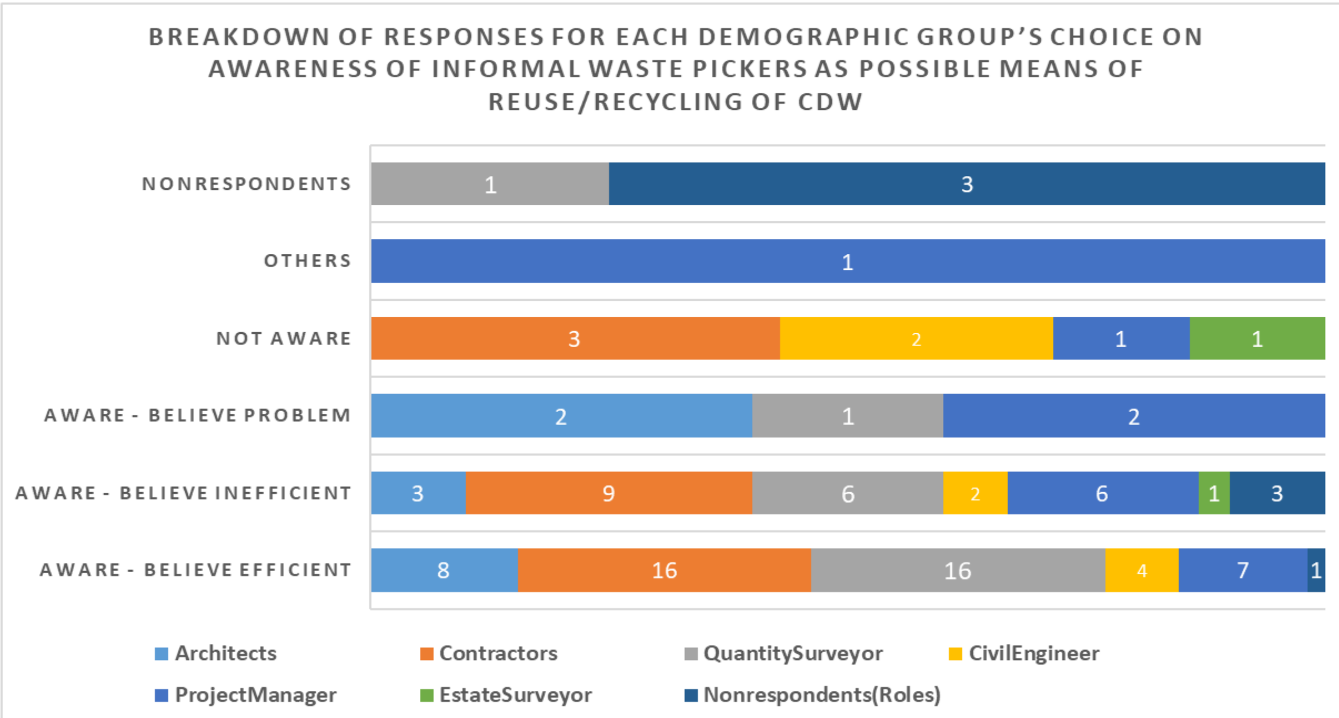

Figure. 4.15: Awareness of waste pickers as possible means of reuse/recycling.

Figure 4.15 shows the distribution of awareness among different demographic groups regarding the potential use of waste pickers to reuse and recycling CDW.

50 participants, being the vast majority (50.7%) of "onsite" personnel like contractors and project managers (who are more likely to see the impact of scavengers), acknowledged their awareness of waste pickers (scavengers) and their significant contribution in recovering recyclable and reusable materials, compared to "offsite" personnel like QS and architects.

87 participants, being majority (85.5%) of "on site" professions (e.g., contractors and project managers) are aware of scavengers and only 5.79% of these believe they are problematic. "Off-

site" professions (e.g., architects and quantity surveyors) only 5 participants (15.15%) are unaware of scavengers and form 20% of the group who consider scavengers to be a problem.

Do you believe that substantial financial savings could be made from effective construction and demolition waste management?

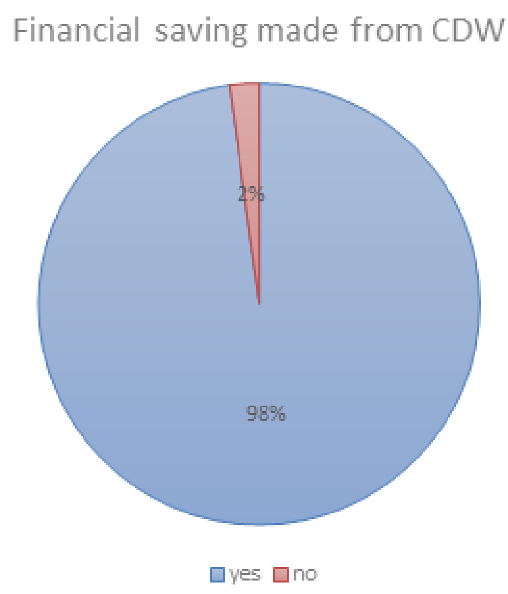

Figure 4.16: Financial savings made from CDW reuse/recycling.

Figure 4.16 displays the opinions of respondents regarding the potential for financial savings through effective CDW management. An overwhelming majority, 92 participants (94%), believed that financial savings are achievable. A small minority, 2 participants (2%) expressed a contrary view, while 4 participants (4.1%) of the respondents did not provide a response to this question. These findings suggest that significant financial savings can be realized by implementing efficient CDW management practices. This is particularly true during the building production phase, as research indicates that a major portion of waste is generated during the construction process, as opposed to waste generated during handling and storage (Kaluarachchi, 2018).

This serves as an incentive for contractors to dedicate more efforts towards minimizing CDW (Amadi and Chijioke, 2018; Kaluarachchi, 2018). Implementing effective CDW management strategies can not only lead to financial benefits but also contribute to sustainable construction.

Figure 4.17 is a breakdown of each demographic group (professionals) view on financial savings made from CDW reuse/recycling.

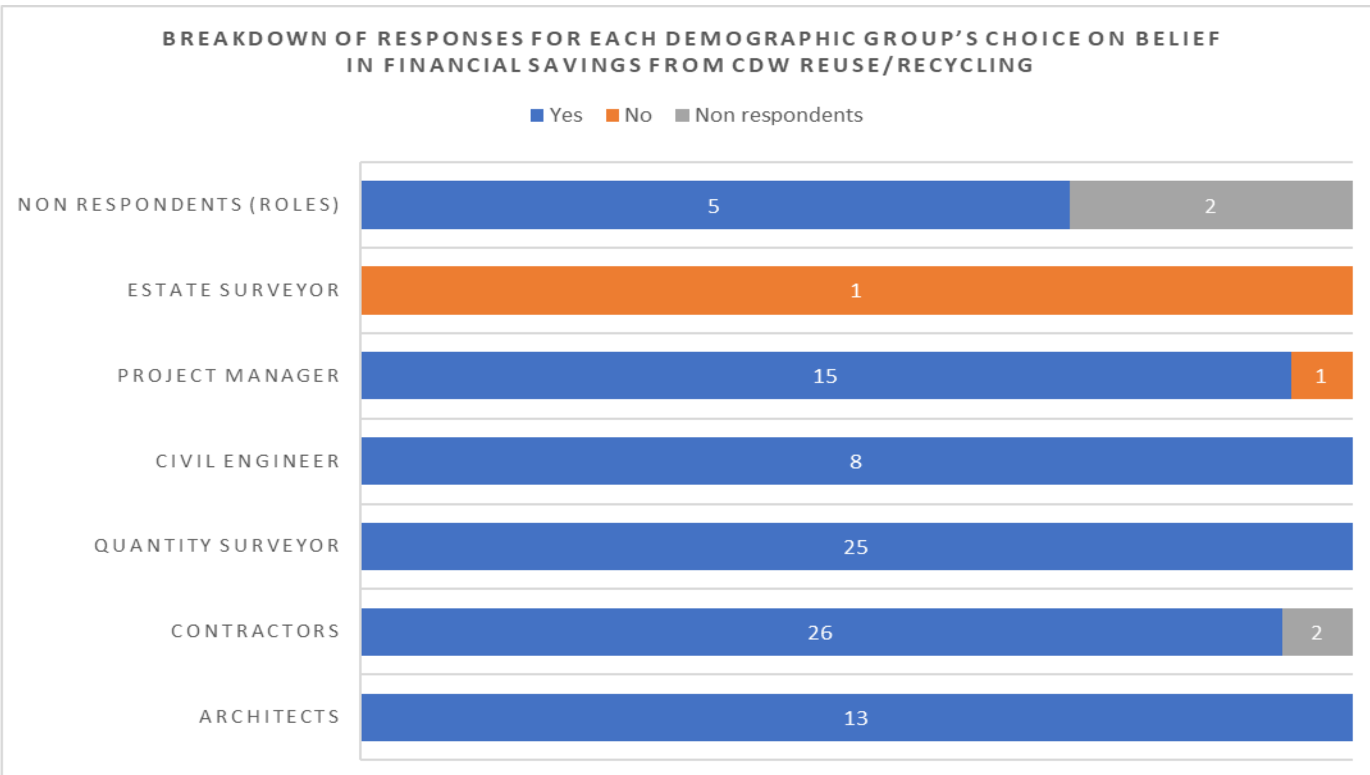

Figure 4.17. breakdown of each demographic group (professionals) view on financial savings made from CDW reuse/recycling.

In Figure 4.17 is a representation of how different professional demographic groups view the potential for savings through CDW reuse/recycling. It is interesting to note that out of all the respondents, there were only two negative respondents to this question: one project manager and one estate surveyor.

4.7 Questionnaire Section 6: Barriers to Reuse/Recycling

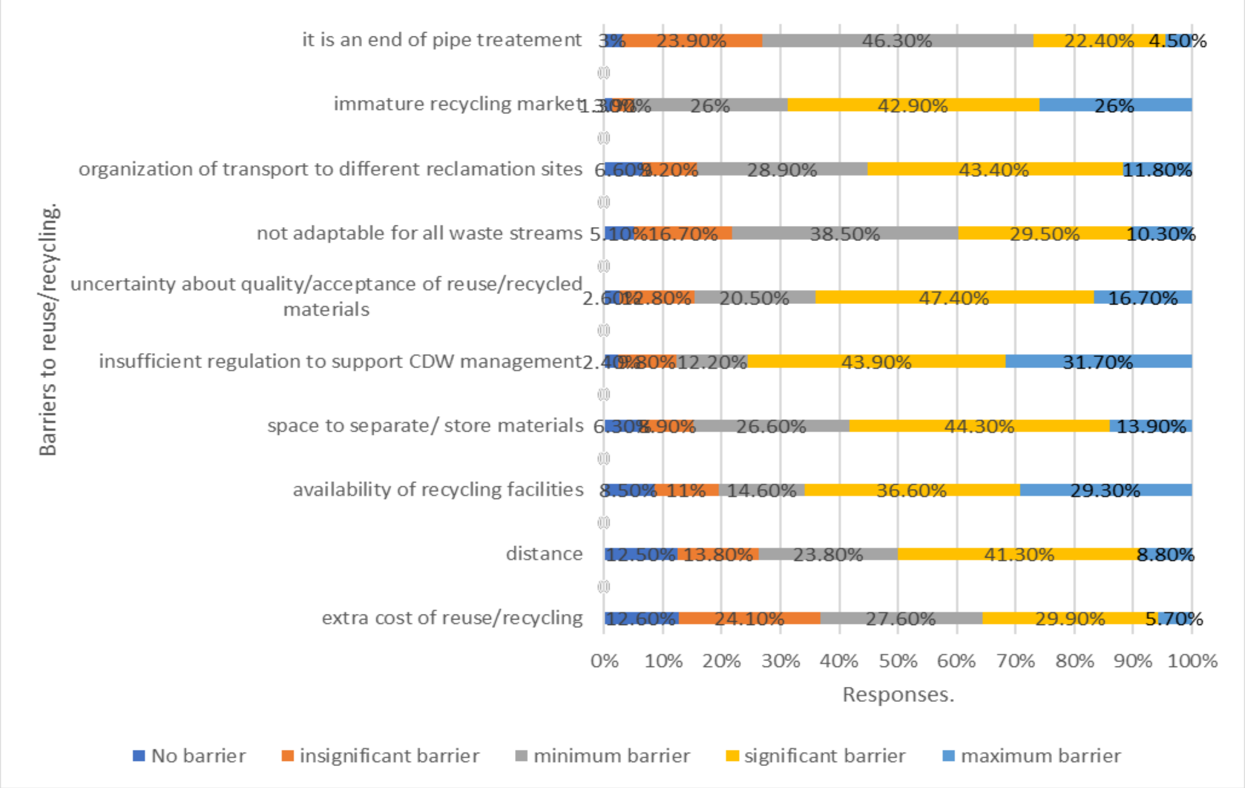

Figure.4.18: Barriers to reuse/recycling.

Figure 4.18 shows the opinions of the survey participants regarding the obstacles to reusing and recycling CDW in Nigeria. The respondents were asked to rate ten barriers on a Likert scale from 1 to 5 ranging from "not a barrier" to " maximum barrier." Combining the responses for " significant barrier" and "maximum barrier " reveals 74 participants being the highest percentage (75.6%) attributed to insufficient regulations to support CDW management. This was followed by 68 participants supporting immature recycling market (68.9%), 65 participants supporting limited availability of recycling facilities (65.9%), 63 participants supporting uncertainty about the quality/acceptance of reused or recycled materials (64.1%), 57 participants supporting inadequate space for separating and storing materials (58.2%), 54 participants supporting difficulties in organizing transportation to different reclamation sites (55.2%), 49 participants supporting issues related to distance (50.1%), 39 participants supporting lack of adaptability for all types of waste streams (39.8%), 35 participants supporting additional costs associated with reuse and recycling (35.6%), and finally, 26 participants supporting perceiving CDW as end-of-pipe treatment (26.9%). As a result, the current system has failed to address these challenges.

This discovery aligns with the observations made by Ike et al. (2018) who pointed out that the government's attempts to implement waste management policies have been unsuccessful so far. While there are regulations in place for handling domestic waste, they are not seen as applying to CDW (Viljoen et al., 2021). This perception contributes to the undervaluation of salvaged materials, which could otherwise be recognized as resources. As a result, contractors are paid to remove CDW from sites and in some cases informal waste workers and private homeowners scramble to acquire these materials.

Another significant obstacle is the state of the recycling market. However, it is important to note that this sector has the potential to contribute economically to Nigeria's gross domestic product (GDP). Currently Nigeria's recycling market is still in its infancy stages compared to other parts of the world. This emphasizes the need for increased investment in this sector. Other major barriers include provision of infrastructure like recycling facilities, well maintained roads for transporting materials and adequate storage space for recyclable materials.

Table 4.6 is a breakdown of the views of different professional roles:

Table 4.6: breakdown of each Professional roles' view on different barriers to Reuse/ (summarized from Table 4.5 0– 4.59 in Appendix E).

Waste Components	Architects	Contractors	Quantity Surveyor	Civil Engineer	Project Manager	Estate Surveyor	Non respondents (Roles)
Maximum Barrier							
Extra cost of Reuse	1	1	1	1	1	0	0
Distance	0	3	3	1	0	0	0
Recycling facilities	1	7	10	3	2	0	1
Storage space	2	2	6	1	0	0	0
Insufficient regulation on CDW	2	9	11	2	2	0	0
Uncertainty of recycled materials	4	2	2	1	2	0	2
Not adaptable for all waste streams	2	0	5	0	1	1	0
Transportation	1	1	4	2	1	0	0
Recycling market	3	5	8	0	2	1	1
It is an end of pipe treatment.	1	0	2	0	0	0	0
Significant Barrier							
Extra cost of Reuse	11	11	11	2	1	0	0
Distance	3	8	14	3	4	0	1
Recycling facilities	3	11	9	0	5	0	2
Storage space	4	12	10	1	5	0	3
Insufficient regulation on CDW	8	12	6	2	5	1	3
Uncertainty of recycled materials	4	15	10	1	6	0	1
Not adaptable for all waste streams	4	8	4	2	5	1	0
Transportation	4	13	10	2	2	1	1
Recycling market	5	11	11	3	4	0	0
It is an end of pipe treatment.	4	6	2	0	3	0	0

Minimum Barrier							
Extra cost of Reuse	5	9	6	0	2	0	2
Distance	3	6	4	1	2	1	2
Recycling facilities	3	4	3	0	2	0	1
Storage space	3	8	6	0	3	0	1
Insufficient regulation on CDW	2	2	3	0	3	2	0
Uncertainty of recycled materials	2	3	6	0	3	1	1
Not adaptable for all waste streams	2	11	10	1	2	0	4
Transportation	4	5	5	1	4	0	0
Recycling market	2	7	4	0	4	0	0
It is an end of pipe treatment.	3	9	12	2	3	1	1
Insignificant Barrier							
Extra cost of Reuse	2	2	6	2	8	0	1
Distance	0	6	2	0	4	0	0
Recycling facilities	3	3	0	1	2	0	0
Storage space	2	0	0	3	2	0	0
Insufficient regulation on CDW	2	1	3	1	3	0	0
Uncertainty of recycled materials	1	1	4	2	2	0	0
Not adaptable for all waste streams	3	1	4	2	3	0	0
Transportation	1	1	1	1	3	0	0
Recycling market	1	0	0	1	1	0	0
It is an end of pipe treatment.	3	3	4	2	3	0	1
No Barrier							
Extra cost of Reuse	2	4	0	1	3	1	1
Distance	4	1	0	1	3	0	1
Recycling facilities	1	0	1	1	3	1	0
Storage space	0	0	1	1	2	1	0

Insufficient regulation on CDW	0	0	0	0	2	0	0
Uncertainty of recycled materials	0	0	0	1	1	0	0
Not adaptable for all waste streams	0	2	0	0	2	0	0
Transportation	0	0	2	0	2	0	0
Recycling market	0	0	0	1	0	0	0
It is an end of pipe treatment.	0	1	0	1	0	0	0

Participants were requested to select one out of a set of ten barriers to reuse and recycling (Table 4.7). The evaluation of barriers to reuse and recycling involved assessing five categories: maximum barrier, significant barrier, minimum barrier, insignificant barrier and minor barrier. The findings, from professionals' selections, are presented in Table 4.7. To obtain a more comprehensive evaluation, the percentage of professional's choices for each category was considered, while maximum and significant barriers were combined. Aggregating the maximum and significant barriers to reuse and recycling revealed that 21 contractors see insufficient regulation as a major barrier. Overall contractors and quantity surveyors had opinions compared to other participating groups. Consequently, insufficient regulation can be considered the obstacle to reuse and recycling in Nigeria.

Any other Barrier to reuse/recycling of construction and demolition waste?

Table.4.7: Other barriers to reuse/recycling.

Any other barrier to reuse/recycling of CDW, please state below	Responses
Economic, social and political barriers to change	18
Unavailability of regular bodies/representation on site	12
Poor orientation of the public on importance of reuse/recycling and hidden treasure therein	8
Incompetence in accurate measurement by craftsmen/artisans	6
Availability of excess financial cash flow in a project	4
Total	48

Based on their experiences, construction participants were asked about other obstacles to reusing and recycling CDW based on their experiences. Table 4.7 provides a summary of respondent's opinions regarding these obstacles in Nigeria. Out of the 98 participants 48 responded to this question, further detailed in Table 4.8

Data presented in Table 4.8 revealed that 18 participants viewed "economic, social and political barriers to change" as barriers to the reuse and recycling of CDW. 12 participants expressed concerns about the absence of regulatory bodies on site which hindered the reuse and recycling efforts. Also, 8 participants highlighted the lack of awareness about the importance of reusing and recycling CDW and its potential. 6 participants pointed out that inaccuracies in measurement by craftsmen/artisans were a problem. Furthermore, 4 participants identified a flow of resources within a project as another hindrance to CDW reuse/recycling in Nigeria. These findings further emphasize the need for regulations to support CDW management in Nigeria.

Figure 4.19 reveals a breakdown of responses from participating groups, regarding the barriers to reusing and recycling CDW.

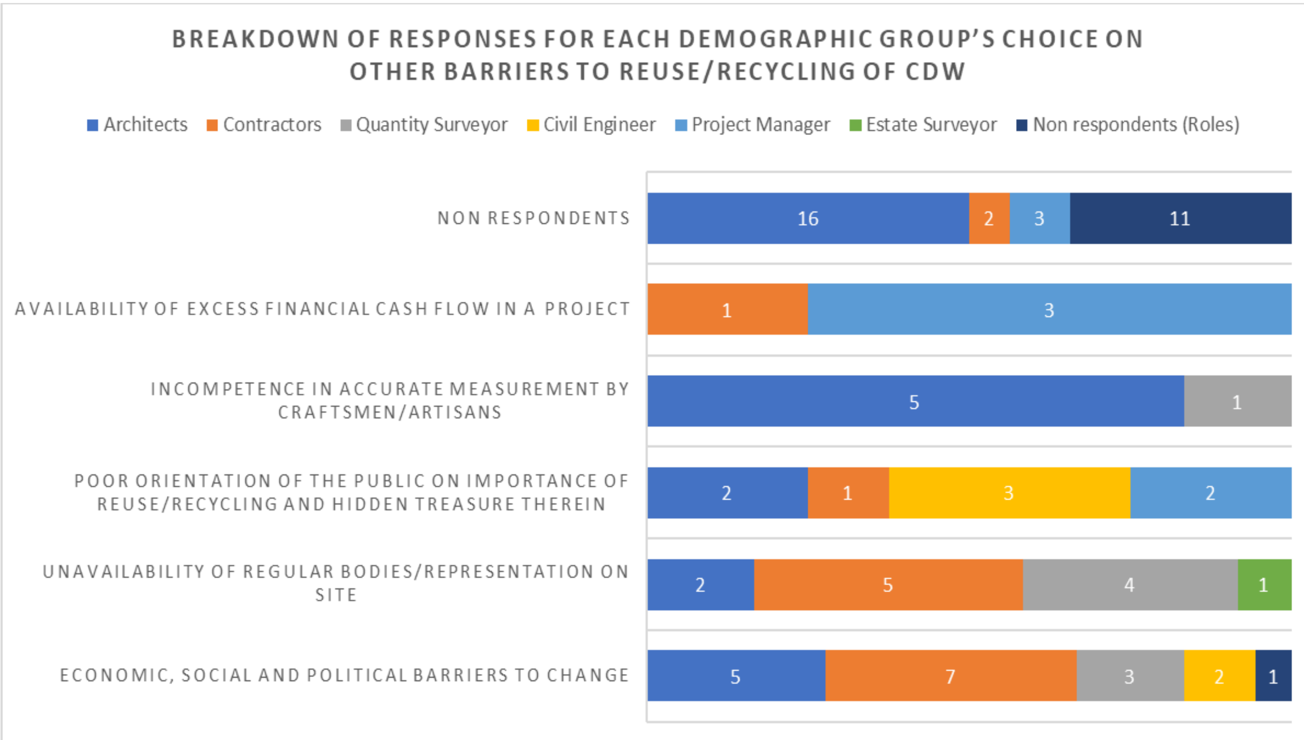

Figure. 4.19: Other barriers to reuse/recycling.

The top three barriers identified were "economic, social and political barriers to change " "lack of bodies on site " and "limited public awareness about the importance of reuse/recycling and the valuable resources within CDW." These obstacles were highlighted by professionals with both onsite and off-site experience. However, the issue of " measurement by craftsmen/artisans" was only mentioned by two off site roles, architects, and quantity surveyors. Similarly, the factor of having a " financial cash flow in a project" was only suggested by two on-site roles - contractors and project managers.

4.8 Questionnaire Section 7: Reuse Methods

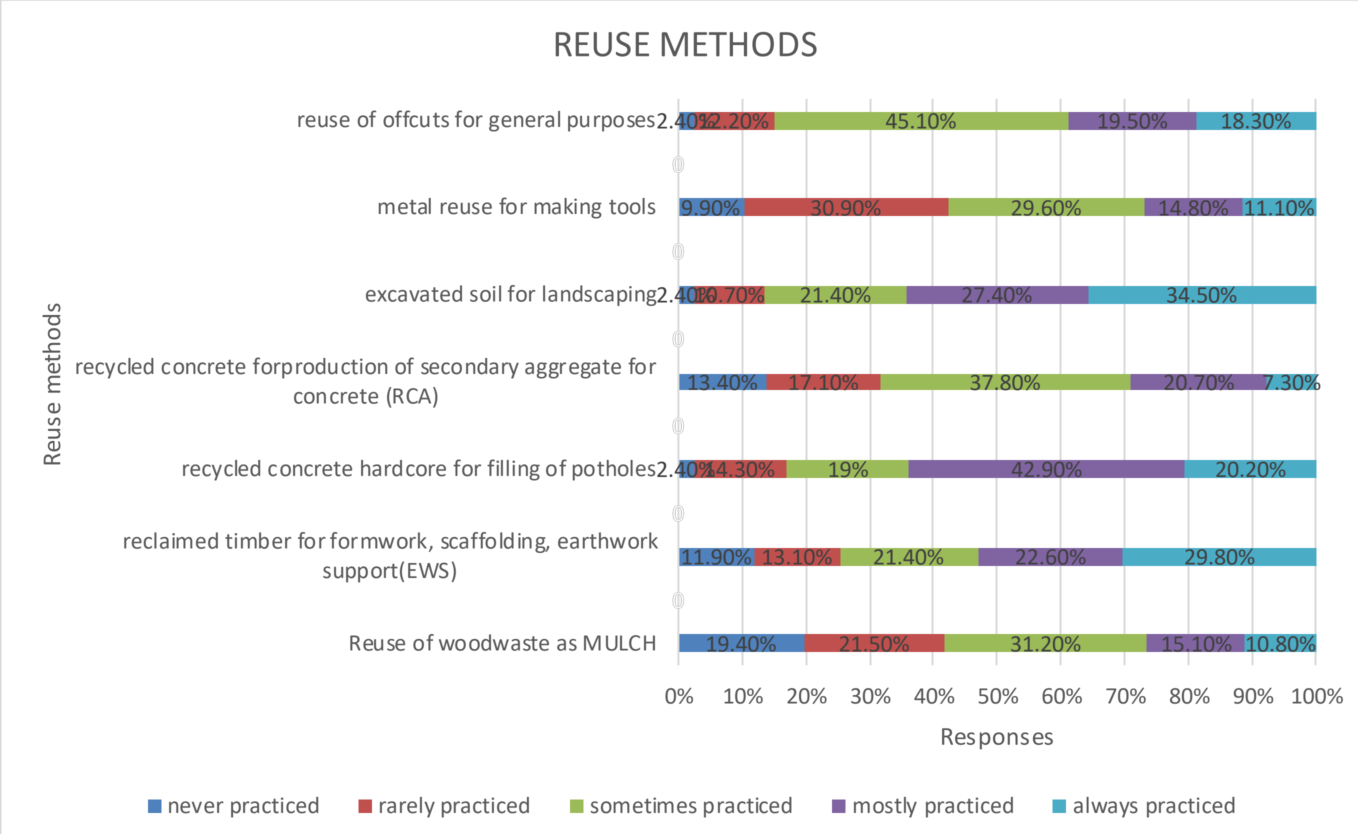

Figure 4.20: Reuse methods

Based on the opinions of respondents, the frequency of implementation of various reuse methods in the Nigerian construction firms was assessed, as depicted in Figure 4.20. The respondents were asked to rate seven reuse methods on a scale of 1 to 5 ranging from "never practiced" to "always practiced." By considering the percentage of responses indicating " mostly practiced" and "always practiced " the most used method was determined. The findings revealed that reusing recycled concrete hardcore for filling potholes, supported by 62 participants (63.1%) was the most adopted approach. Additionally reusing excavated soil for landscaping, supported by 61 participants (61.9%) and reclaimed timber for formwork, supported by 51 participants (52.4%) were other reuse choices. On the other hand, utilizing offcuts for general purposes, supported by 37 participants (37.8%) recycling concrete for producing secondary aggregates, supported by 27 participants (28%) reusing wood waste as mulch and repurposing metal waste were fewer common practices, supported by 25 participants with equal percentages of 25.9% each. These results highlight that numerous CDW materials already have established applications in terms of reuse and recycling.

The selection of reuse methods is influenced by the characteristics of CDW materials. For instance, recycled concrete hardcore possesses stiffness and bearing capacity making it suitable for filling potholes. This corresponds with research findings (Amadi and Chijioke, 2018; Kaluarachchi, 2018) that emphasize the use of concrete as a construction material in Nigeria. Consequently, it is common for CDW to be reused or sold on site as scrap.

Moreover, excavated soil is often reused, due to the participants' background in contracting and their inclination to reuse it other projects. While Amadi and Chijioke (2018) discovered that excavated soil is typically disposed of in landfills they recommended its reuse in other projects as a way for contractors to reduce landfill related costs.

The extensive reuse of timber can be attributed to its high scrap value, hence used as firewood for cooking baking and various industries utilizing it for heat generation through burning. Additionally reclaimed timber exhibits strength when subjected to tension and compression along the axis making it suitable for diverse applications such as scaffolding and earthwork support operations. Supporting this point Abdullahi and Lee (2018) stated that reclaimed timber is commonly utilized for scaffolding purposes and sold to households, for firewood or other uses.

Table 4.8: ***Breakdown of responses for each demographic group's***

(professional roles) choice on Reuse methods (extracted from Table 4.60-4.66 in appendix E).

Waste Components	Architects	Contractors	Quantity Surveyor	Civil Engineer	Project Manager	Estate Surveyor	Non respondents (Roles)
Always practiced							
Reused wood as MULCH	1	3	1	1	4	0	0
Reclaimed timber	3	6	7	3	4	0	2
Recycled concrete for hardcore	6	1	8	1	1	0	0
Recycled concrete as secondary aggregate	2	2	1	1	0	0	0
Excavated soil	4	7	5	4	8	0	0
Reused metals	2	3	2	1	1	0	0
Offcuts	2	5	5	2	1	0	0
Mostly practiced							
Reused Wood as MULCH	2	6	4	1	2	0	0
Reclaimed timber	4	7	4	2	2	1	0
Recycled concrete for hardcore	2	14	7	3	7	1	3
Recycled concrete as secondary aggregate	2	6	5	1	2	0	1
Excavated soil	4	8	8	0	1	1	0
Reused metals	0	6	4	0	1	1	0
Offcuts	2	4	4	1	5	0	0
Sometimes practiced							
Reused Wood as MULCH	3	8	12	0	3	0	3
Reclaimed timber	2	4	8	0	4	0	0

Recycled concrete for hardcore	3	5	4	1	3	0	0
Recycled concrete as secondary aggregate	2	10	9	0	5	1	4
Excavated soil	3	4	8	1	2	0	0
Reused metals	5	7	5	1	5	0	1
Offcuts	7	13	8	0	5	1	4
Rarely Practiced							
Reused Wood as MULCH	3	7	2	3	3	1	1
Reclaimed timber	1	3	2	1	2	0	2
Recycled concrete for hardcore	1	3	4	1	2	0	1
Recycled concrete as secondary aggregate	3	4	2	4	2	0	0
Excavated soil	1	4	1	1	1	0	1
Reused metals	4	5	8	2	3	0	3
Offcuts	2	1	5	2	0	0	0
Never Practiced							
Wood Reuse as MULCH	4	6	3	1	4	0	0
Reclaimed timber	2	5	2	0	1	0	0
Recycled concrete for hardcore	1	1	0	0	0	0	0
Recycled concrete as secondary aggregate	2	2	5	0	2	0	0
Excavated soil	0	3	1	0	0	0	0
Reused metals	0	3	3	1	1	0	0
Offcuts	0	1	1	0	0	0	0

Moreover, Participants were given the option to select from a range of seven methods for reusing CDW (refer to Table 4.9). The evaluation of these reuse methods was determined by five categories; always practiced, mostly practiced, sometimes practiced, rarely practiced, and never practiced. Table 4.9 reveals the outcomes of the choices made by professionals. To provide a more generalized assessment, the percentage of professional's choices for each category was considered. Furthermore, the categories of always practiced and mostly practiced were aggregated. Each group's assessment was based on their highest vote counts, within each segment.

Aggregating always practiced and mostly practiced reuse methods saw most contractors and quantity surveyors (15), each identifying the use of Recycled concrete hardcore for filling of potholes as the mostly practiced reuse method.

Overall, the votes from contractors (being the professional on site), were the strongest, followed by quantity surveyors, while the remaining groups had lower participation.

4.9 Questionnaire Section 8: Factors to enhance CDW Management

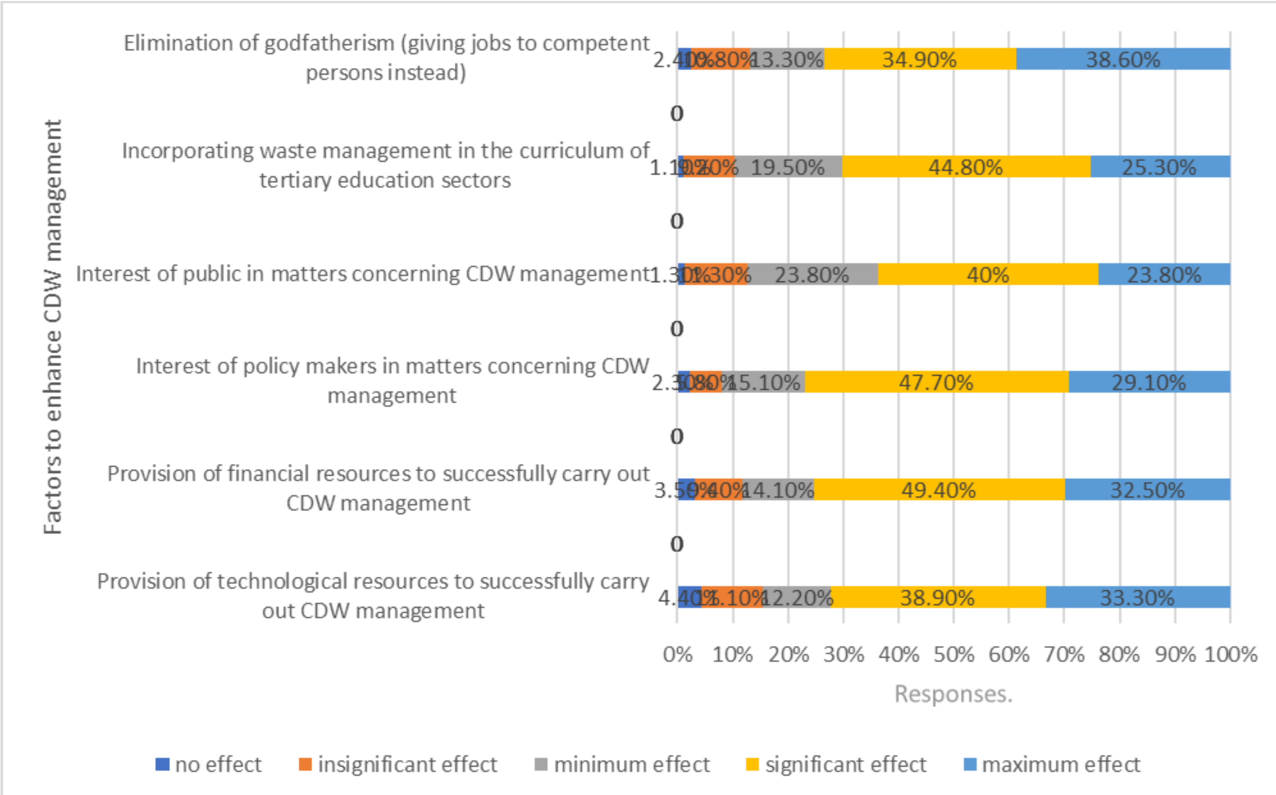

Figure. 4.21 Factors to enhance CDW management in Nigeria.

In Figure 4.20, the 98 respondents were asked to choose from a scale of 1-5 (no effect, insignificant effect, minimum effect, significant effect, and maximum effect) the factors that could enhance CDW management in Nigeria. The cumulative percentage of significant and maximum effect, when combined, revealed that the provision of financial resources to successfully carry out CDW management, supported by 80 participants had the highest impact with a cumulative percentage of 81.9%. This was followed by the interest of policymakers in CDW matters, supported by 75 participants (76.8%), the elimination of nepotism (ensuring the most qualified individuals are given the right job) (73.5%), the provision of technological resources, supported by 71 participants (72.2%), the incorporation of waste management in the curriculum of tertiary education sector, supported by 69 participants (70.1%), and lastly, the interest of the public in CDW management matters, supported by 63 participants (63.8%). This suggests that appropriate funding should be allocated for CDW management in every construction contract. As earlier suggested by participants, there are also issues relating to policy, nepotism, education and resources hindering CDW management in Nigeria.

Findings from literature consider that CDW management in Nigeria is not solely the responsibility of government authorities, but also that of the client and contractors (Faniran and Caban, 2007; Tongo, 2023). However, the contractor often fails to fully comply because it is not a formal responsibility and there are no specific contract conditions related to it. Although the government oversees solid waste management in Nigeria, the level of commitment to waste management is low (Sridhar, M.K.C., Oluborode, J.A. and Zacchaeus, 2017; Aboginije, Aigbavboa and Thwala, 2021). The commitment of the government to CDW management can be measured through the allocation of finances to the CDW management sector (Nasidi *et al.*, 2018).

Table 4.10 is a breakdown of responses for each demographic group's (professional roles) choice on Factors to enhance CDW management in Nigeria.

Table 4.9: Professional's view on different factors to enhance CDW management

(summarized from Table 4.67- 4.72 in Appendix E)

Waste Components	Architects	Contractors	Quantity Surveyor	Civil Engineer	Project Manager	Estate Surveyor	Non respondents (Roles)
Maximum effect							
Technical resources	3	8	10	1	4	1	3
Financial resources	1	6	8	1	3	1	0
Policy makers interest on CDW	4	8	9	2	1	1	1
Public interest on CDW	2	6	8	1	1	1	0
Waste management in tertiary education	2	4	11	1	3	0	1
Elimination of God fatherism	4	8	12	2	5	0	1
Significant effect							
Technical resources	7	13	12	2	2	0	0
Financial resources	8	15	11	2	4	0	3
Policy makers interest on CDW	5	13	14	2	5	0	3
Public interest on CDW	4	10	10	2	6	0	0
Waste management in tertiary education	7	15	8	3	6	1	0
Elimination of God fatherism	5	9	8	3	2	0	0
Minimum effect							
Technical resources	1	6	2	1	0	0	1
Financial resources	2	4	3	0	2	0	1
Policy makers interest on CDW	3	4	1	0	4	0	0
Public interest on CDW	6	5	2	0	4	0	2

Waste management in tertiary education	2	7	5	0	2	0	1
Elimination of God fatherism	3	3	2	0	2	0	1
Insignificant effect							
Technical resources	2	2	0	1	5	0	0
Financial resources	2	0	1	1	3	0	1
Policy makers interest on CDW	1	0	0	1	3	0	0
Public interest on CDW	1	3	3	1	1	0	0
Waste management in tertiary education	2	0	0	2	2	0	0
Elimination of God fatherism	5	9	8	3	2	1	0
No effect							
Technical resources	0	1	0	1	2	0	0
Financial resources	0	1	0	1	1	0	0
Policy makers interest on CDW	0	1	0	1	0	0	0
Public interest on CDW	0	0	0	1	0	0	0
Waste management in tertiary education	0	0	0	0	0	0	1
Elimination of God fatherism	0	2	0	0	0	0	0

To ensure a more comprehensive evaluation, the percentage of professionals' choices within each category were considered while combining the significant and maximum effects. This assessment was conducted for each group based on their vote counts in each segment.

Aggregating maximum effect and significant effect saw majority (23) of quantity surveyors considering Interest of policy makers in matters concerning CDW management. Contractors had the strongest votes followed by quantity surveyors. The remaining groups had lower participation.

Below is a list of waste management strategies. Please rank the extent to which each strategy has been applied by your company in your recent projects.

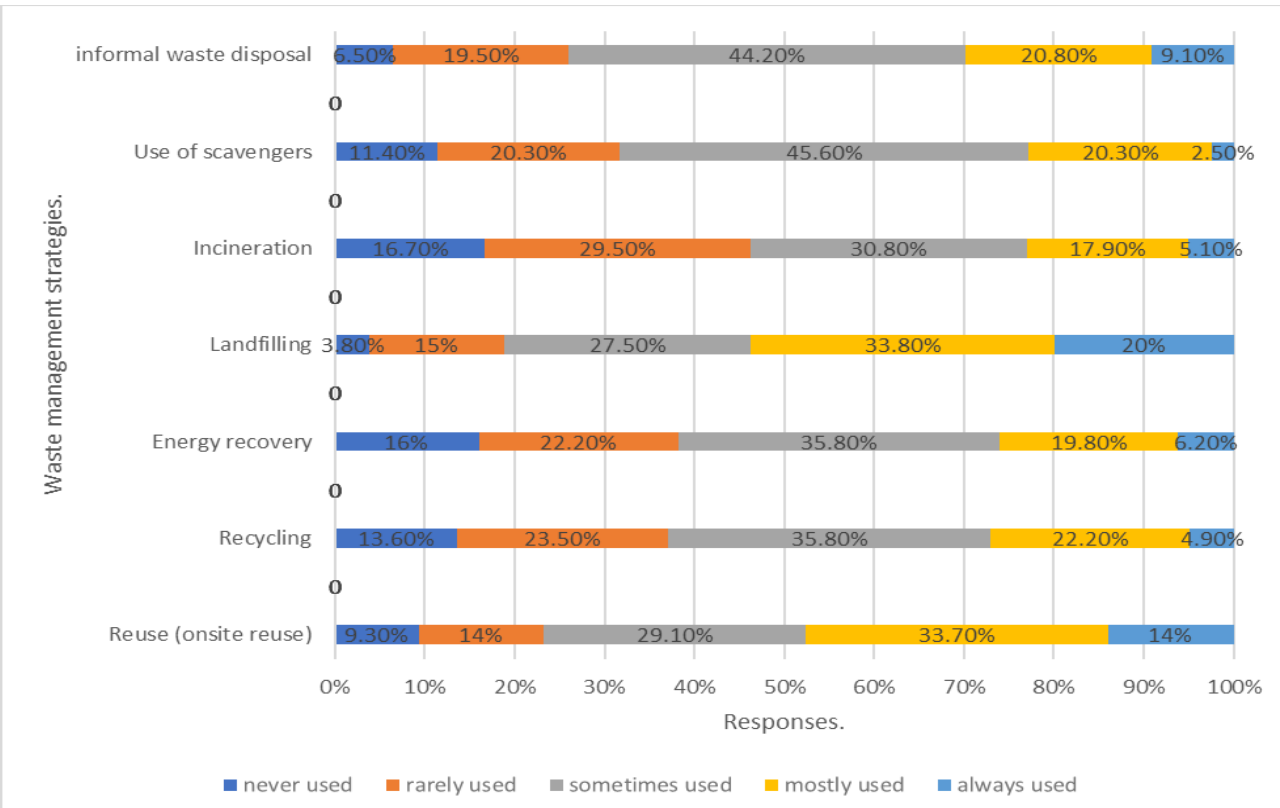

Figure 4.22 Waste management strategies

Figure 4.22 showcases participants' perspectives on how waste management strategies (on site reuse, recycling, energy recovery, landfilling, incineration, informal waste reuse and scavenger utilization) have been applied in their contracts. Respondents were asked to rate these strategies on a scale from 1 to 5 (never applied, rarely applied sometimes applied, applied, and always applied).

Mostly applied waste management strategies in Nigeria, supported by 53 participants with a percentage of 53.8%, focus on landfilling. On-site reuse follows closely behind, supported by 47 participants at 47.7% while informal waste disposal, recycling, energy recovery, incineration and scavenging are also employed to varying degrees, supported by 29, 27, 26, 23 and 22 participants (29.9%, 27.1% 26%, 23% and 22.8% respectively). These numbers highlight the need for a more sustainable waste management practices in the Nigerian construction industries.

Literature findings further revealed the practice of landfilling in Nigeria has raised health concerns in areas like Ojota in Lagos and the Aba Port Harcourt expressway. In these locations waste is being improperly disposed near the expressway posing risks to both humans and the environment. The indiscriminate disposal of waste in cities such as Aba, Lagos, Port Harcourt and Ibadan is becoming an issue. Given their population and thriving business activities that generate revenue for their respective states (Ifediora, 2021) finding effective solutions is crucial.

On site reuse is an approach that aims to reduce costs, minimize raw material wastage, optimize space utilization at construction sites and foster the adoption of sustainable technologies for CDW. Various materials can be reused onsite, such as wooden profiles, wooden frames for decking, wooden frames for lintel, wooden planks for scaffolding and bamboo sticks for scaffolding. Additionally cement bags can serve purposes like erosion control (as sandbags) damp proofing and decking. Broken tiles find life as flooring and skirting applications. The recycling of construction waste in Nigeria encompasses materials like plastic, iron, nonferrous metals and aluminum. Welders and iron benders reuse iron rods, metal sheets, beams/column profiles for purposes like creating iron gates deterrents for windows and doors and handrails (Awoyera et al., 2022).

The use of renewable energy systems in Nigeria has seen an increase recently with the adoption of CDW for energy recovery (Awoyera et al., 2022). Sawdust obtained during wood sawing processes contributes significantly to the amount of construction waste utilized for energy generation. Furthermore, biodigesters are employed in buildings and construction sites to extract energy from waste (Audu et al., 2020). Incineration practices have also been adopted as a means of waste management by disposing of waste through incinerators.

However, the rise of urbanization and the subsequent increase in construction to accommodate the growing population has also caused a decline in the use of incineration in Nigeria (Ezechi et al. 2017; Audu et al., 2020).

While participants recognize the potential of scavengers as a means of waste management (as shown in Figure 4.22), employing them is viewed as unusual. This perception might stem from existing stereotypes surrounding waste and waste pickers in Nigeria. Therefore, this study emphasizes the need for awareness and education on waste management practices across the country. The collaboration between the Federal Ministry of Environment and the National Orientation Agency should focus on developing waste management policies in Nigeria and educating citizens about waste disposal. Waste workers should undergo training and orientation regarding waste disposal techniques and control measures at landfills, incinerators and other dumpsites.

Furthermore, it is crucial to have waste disposal trucks and efficient recovery systems at landfills. In regions with sandy terrain for example, waste disposal trucks getting stuck at the entrance to landfills can result in waste workers erroneously dumping their waste at the entrance. This obstructs access to the landfill and results in underutilization until access is cleared.

Table 4.10 is a breakdown of responses for each demographic group's (professional roles) choice on Waste management strategies.

Table 4.10: Professional view on different waste management strategies

(summarized from Table 4.67- 4.72, Appendix E).

Waste Components (Abbreviated)	Architects	Contractors	Quantity Surveyor	Civil Engineer	Project Manager	Estate Surveyor	Non respondents (Roles)
Maximum effect							
Reuse (on site)	3	4	2	1	1	0	1
Recycling	2	1	0	0	1	0	0
Energy recovery	0	0	2	0	3	0	0
Landfilling	3	4	4	2	3	0	0
Incineration	1	2	0	0	1	0	0
Use of scavenger	0	0	2	0	0	0	0
Informal waste disposal	1	0	4	0	2	0	0
Significant effect							
Reuse (on site)	2	9	10	3	3	0	2
Recycling	0	7	6	2	1	0	2
Energy recovery	4	4	6	0	1	1	0
Landfilling	6	11	6	2	2	0	0
Incineration	1	2	4	2	4	1	0
Use of scavenger	2	4	2	3	3	0	2
Informal waste disposal	4	2	3	1	3	0	3
Minimum effect							
Reuse (on site)	4	7	9	0	3	1	1
Recycling	5	11	8	0	5	0	0
Energy recovery	3	14	3	1	6	0	2
Landfilling	3	6	7	0	2	1	3
Incineration	2	9	6	1	3	0	3
Use of scavenger	7	9	12	1	4	0	3

Informal waste disposal	5	11	10	1	5	1	1
Insignificant effect							
Reuse (on site)	1	4	3	1	2	0	1
Recycling	4	4	5	1	3	0	2
Energy recovery	2	1	8	4	2	0	1
Landfilling	0	3	4	1	3	0	1
Incineration	4	7	8	1	2	0	1
Use of scavenger	3	7	2	1	2	1	0
Informal waste disposal	0	4	6	1	2	0	2
No effect							
Reuse (on site)	1	1	0	0	6	0	0
Recycling	1	1	4	2	2	1	0
Energy recovery	2	4	5	0	1	1	1
Landfilling	0	0	2	0	1	0	0
Incineration	2	2	5	1	3	0	0
Use of scavenger	0	3	5	0	1	0	0
Informal waste disposal	1	1	1	2	0	0	0

To provide a more comprehensive evaluation, the percentage of professionals who selected specific categories was considered. This assessment was conducted for each group based on their vote counts, in each segment. Aggregating maximum and significant**,** it was found that most contractors considered landfilling as their waste management option. The remaining strategies received lower percentages in comparison, hence were not considered significant.

Any other measures to enhance construction waste reuse/recycling in Nigeria:

Table 4.11 Other measures to enhance CDW reuse/recycling in Nigeria:

Other measures to enhance construction waste reuse/recycling in Nigeria:	Responses
Making sure reuse/recycling is allowed/included in specifications.	14
More awareness to the client and public on importance of CDW	12
Education of individuals, public and private sector contractors, and the importance of reuse/ recycling of CDW.	10
Delegation of environmental teams to visit and enforce onsite reuse/recycling	8
Total	44

Figure 4.23 Breakdown of responses for each demographic group for other measures to enhance construction waste reuse/recycling in Nigeria.

In addition to their experiences, participants were also asked to list other means to enhance CDW reuse/recycling in Nigeria. Out of the 98 participants 44 respondents provided answers to this question. The summarized results are presented in Table 4.11.

Based on the findings from Table 4.11, 14 respondents suggested including reuse/recycling requirements in specifications to manage CDW. Twelve participants emphasized the importance of increasing awareness among clients and the public about CDWs' significance. Ten respondents expressed the belief that educating individuals and contractors in both private and public sectors, about the value of reuse/recycling could contribute to CDW management. Eight participants believed in assigning environmental responsibilities to oversee and enforce practices related to on site reuse and recycling.

Figure 4.23 is a breakdown of responses across different demographic groups regarding alternative measures to enhance the reuse and recycling of CDW in Nigeria

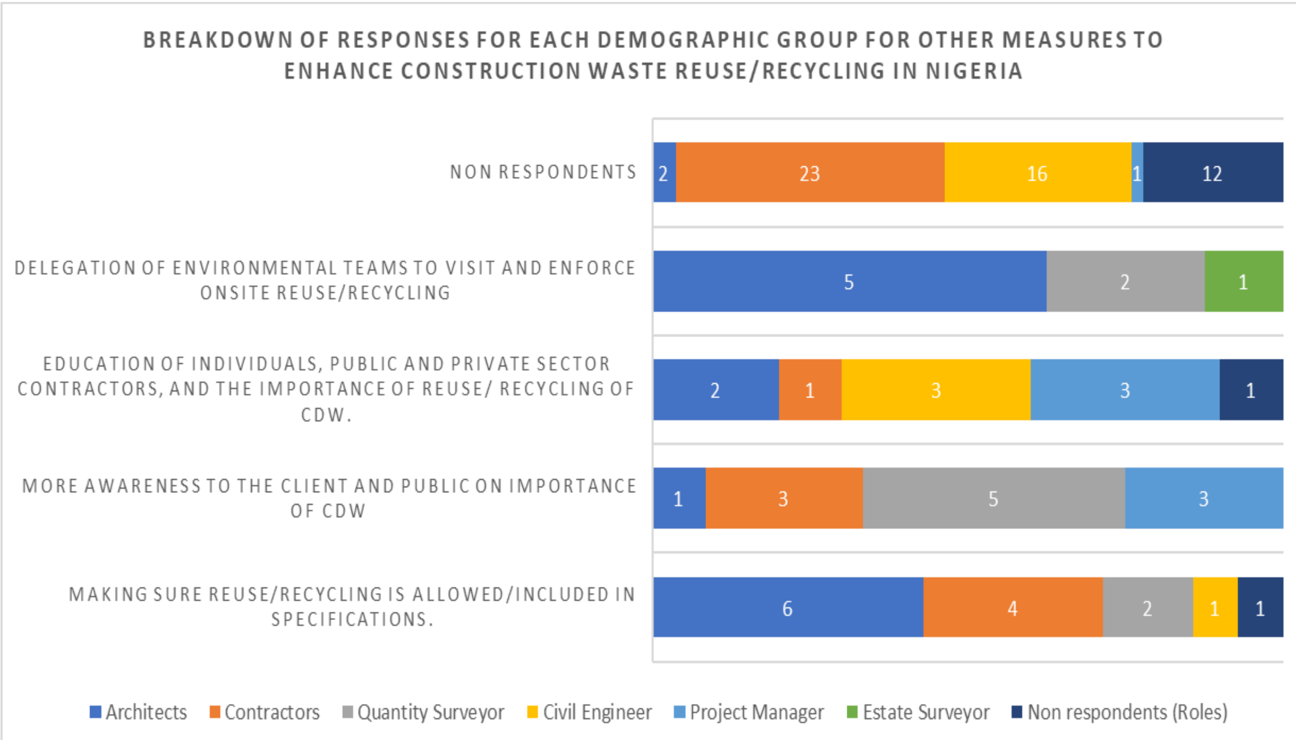

Figure 4.23: breakdown of responses across different demographic groups regarding alternative measures to enhance the reuse and recycling of CDW in Nigeria.

This breakdown indicates that all the suggested measures to enhance CDW reuse/recycling were supported by multiple professionals.

4.10 Section 8: Effect of CDW on the Environment

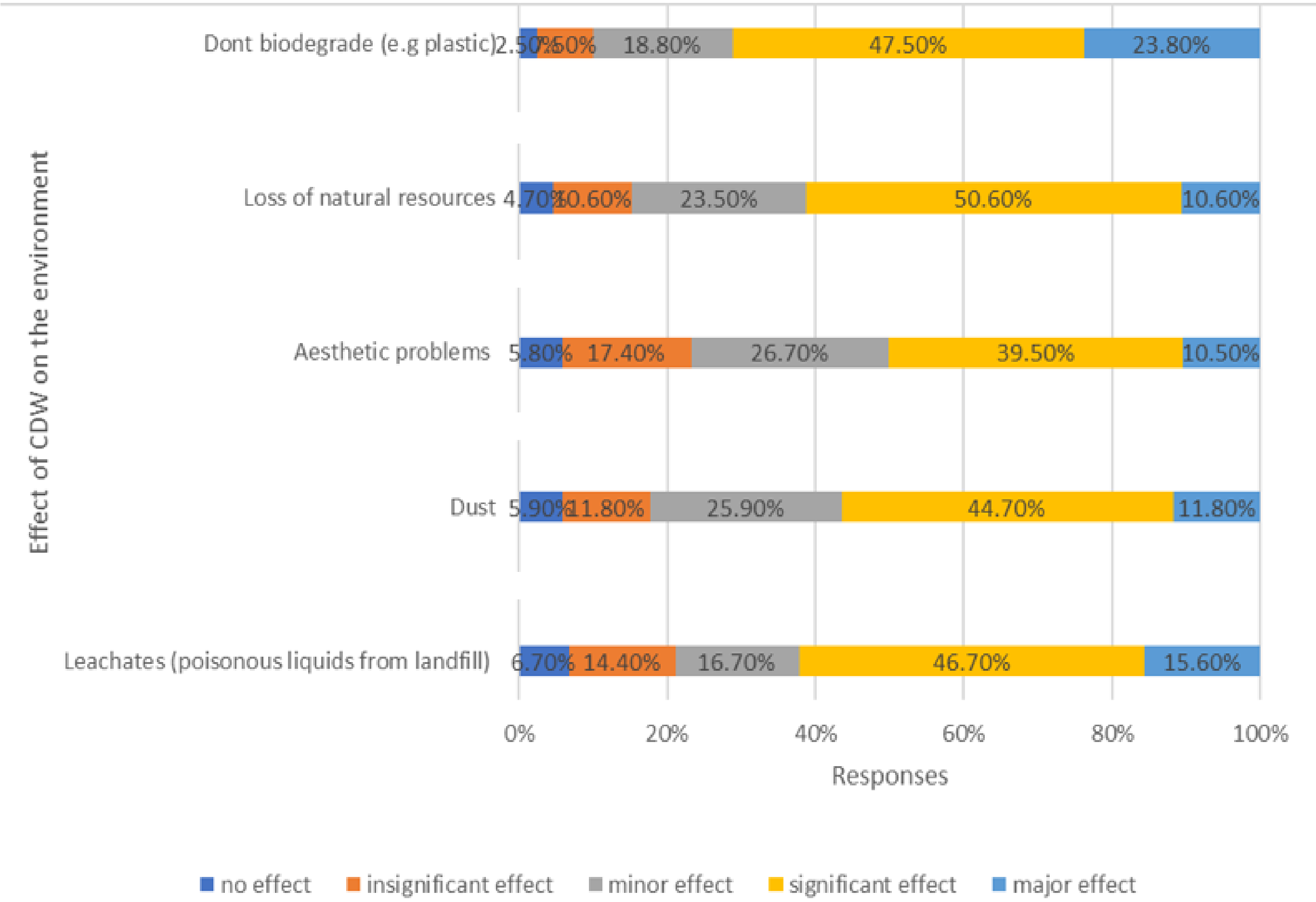

Figure. 4.24: Effect of CDW on the environment

Figure 4.24 represents participants responses on effects of CDW on the environment. The impact was assessed using a five-point Likert scale ranging from no impact to major impact. The cumulative percentage of significant and major effects show that non-biodegradable materials, such as plastics are believed to have a substantial environmental impact, supported by70 participants (71.3%). This suggests that construction sites generate an amount of biodegradable waste like plastics and glass which greatly affects our environment (Olorunnimbe et al., 2012; Tisserant et al., 2017). To address this issue, it is recommended to implement on-site solutions or explore local alternatives such as involving scavengers, rather than solely relying on centralized waste collection and landfill disposal.

Furthermore, 61 participants (62%) expressed concern about leachates – substances released from landfills. Construction materials consist of components that can react with soil, water and other substances. These reactions can lead to changes in CDW, causing corrosion of metallic materials through oxidation. The erosion and chemical substances have the potential to seep into the ground causing contamination, from toxic compounds (Kaluarachchi, 2018; Rondinel Oviedo, 2023). When landfills are located close to water bodies, it can have effects on water quality and shallow aquatic regions.

60 participants (61.2%) expressed concerns about the depletion of resources as a major effect. This includes landfills filled with CDW which could be used for agricultural or other purposes. Additionally, dust was acknowledged as an issue by 55 participants (56.5%). Various construction activities such as sand and gravel dumping, loading CDW onto pay loaders mixing plaster of Paris sawing wood and blending cement produce an amount of dust particles. Lastly aesthetics problems were identified by 49 (50.1%) participants as an impact. Improper disposal of CDW leads to pollution that creates an eyesore in the surrounding areas and becomes a nuisance.

Table 4.12. is a breakdown of responses for each demographic group’s (professional roles) concerns relating to the effect of CDW on the environment.

Table 4.12: Professional view on various effects of CDW on the environment

(summarized from Tables 4.80.1- 4.84, Appendix E).

Waste Components (Abbreviated)	Architects	Contractors	Quantity Surveyor	Civil Engineer	Project Manager	Estate Surveyor	Non respondents (Roles)
No effect							
Leachates	1	1	1	0	3	0	0
Dust	1	1	2	1	0	0	0
Aesthetic problem	2	0	3	0	0	0	0
Loss of natural resources	1	0	2	1	0	0	0
Non biodegradables	0	1	0	1	0	0	0
Significant effect							
Leachates	2	3	3	4	4	0	0
Dust	3	2	1	1	3	0	0
Aesthetic problem	3	4	1	1	6	0	0
Loss of natural resources	2	4	1	1	2	0	0
Non biodegradables	0	4	0	1	1	0	0
Minor effect							
Leachates	3	4	2	2	2	0	2
Dust	5	6	7	0	4	0	2
Aesthetic problem	2	12	1	1	4	0	2
Loss of natural resources	3	6	7	0	3	0	1
Non biodegradables	4	3	7	0	0	0	1
Insignificant effect							
Leachates	4	17	16	1	2	1	2
Dust	3	2	1	1	3	1	0
Aesthetic problem	4	10	13	3	3	1	0
Loss of natural resources	5	12	12	4	6	1	3
Non biodegradables	7	10	12	1	6	1	2

Major effect							
Leachates	2	4	2	3	3	0	0
Dust	1	0	7	1	1	0	0
Aesthetic problem	2	0	4	1	0	0	2
Loss of natural resources	2	7	2	0	1	0	0
Non biodegradables	1	4	5	3	5	0	1

The results of the decisions made by professionals are displayed in Table 4.13. To provide a more comprehensive evaluation, the percentage of professionals who selected a specific category as well as the classification of major and significant effects were combined.

Aggregating major and significant effects revealed that most contractors (21 in total) identified Leachate as being a major impact of CDW on the environment. Overall contractors and quantity surveyors had the level of participation compared to groups.

4.11 Questionnaire Section 9: Effect of CDW on the Economy

In your opinion, rank the effects of the following economic impacts of CDW on construction businesses.

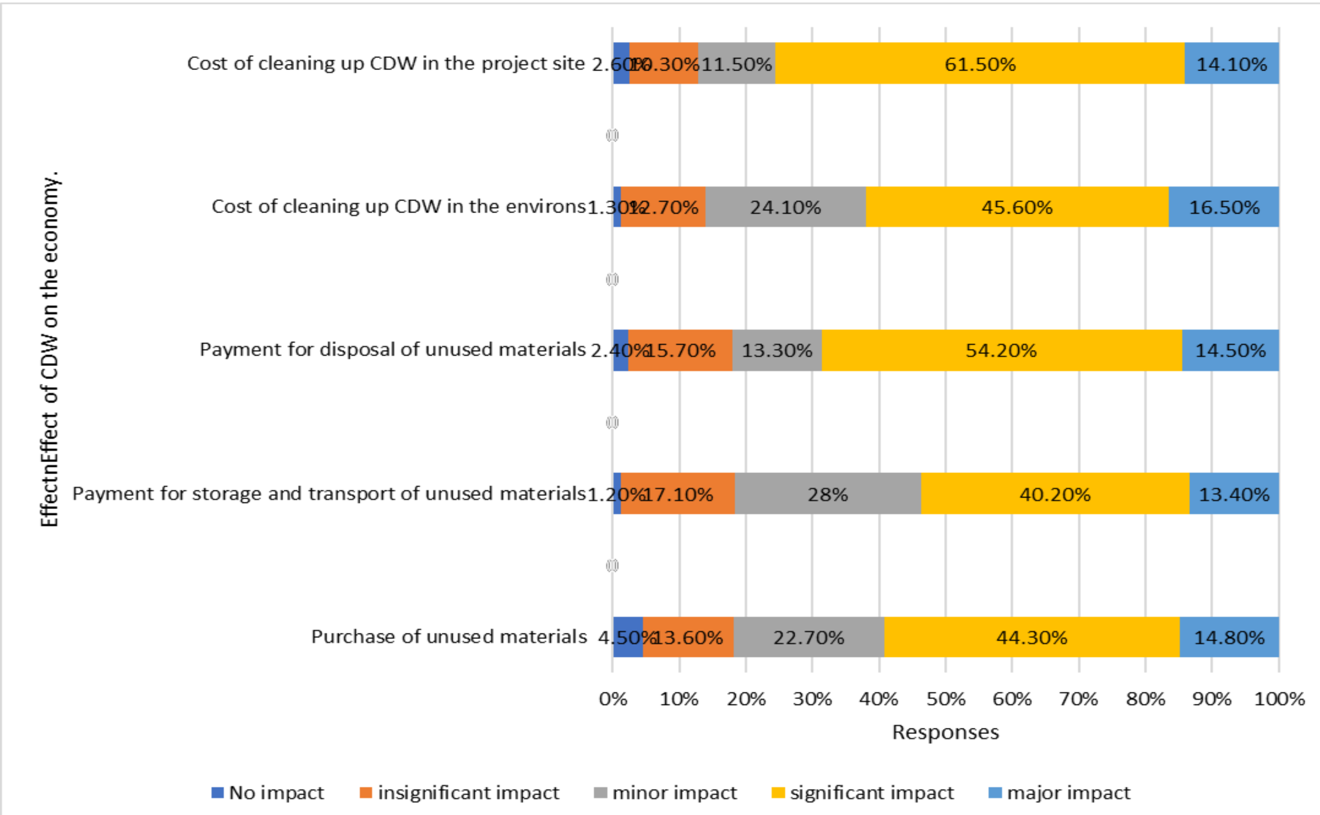

Figure 4.25: Effect of CDW on the economy.

The opinions of respondents regarding CDWs' impact on the economy are illustrated in Figure 4.24. The impacts were evaluated using a 5-point Likert scale ranging from no impact to major impact. Combining the responses that indicated major and significant impacts, it becomes clear that the cost associated with cleaning up CDW at project sites, supported by 74 participants at 75.6%. Following closely is the expense related to disposing of materials, supported by 67 participants, which accounts for 68.7%. The third ranking impact is attributed to the cost of cleanup, supported by 61 participants at 62.1% while the purchase of unused materials, supported by 58 participants ranks fourth at 59.1%. Lastly, payment required for storing and transporting materials, supported by 53 participants stands at 53.6%. These findings align with existing literature suggesting that cleaning up CDW at project sites can substantially affect construction costs (Kim, Nguyen and Luu, 2020). Effective CDW management can lead to reduced project costs and demonstrate the commitment of construction participants to the environment. In some cases, contractors may need to acquire or rent containers for storing unused construction materials, which can potentially increase the total cost in the long run. Furthermore, the cleanup expenses contribute to the project's cost. To accomplish this, it may be necessary to hire individuals or professional companies which would further increase the project cost (Kim, Nguyen and Luu, 2020).

Table 4.13 is a breakdown of responses for each demographic group’s (professional roles) choice on effect of CDW on the economy**.**

Table 4.13: Professional view on effect of CDW on the economy

(summarized from Table 4.85 – 4.89 in Appendix E)

Waste Components (Abbreviated)	Architects	Contractors	Quantity Surveyor	Civil Engineer	Project Manager	Estate Surveyor	Non respondents (Roles)
Major impact							
Purchase of used materials	3	4	3	2	0	0	1
Payment for storage and transport unused materials	1	3	4	3	0	0	0
Payment for disposal of unused materials	1	4	4	1	0	0	2
Cost of cleaning up CDW	2	5	2	2	2	0	0
Cost of cleaning up CDW in the project site	1	4	0	1	1	0	0
Significant impact							
Purchase of used materials	4	12	10	2	7	1	3
Payment for storage and transport unused materials	6	7	12	2	3	1	2
Payment for disposal of unused materials	8	12	15	2	5	0	3
Cost of cleaning up CDW	7	7	13	2	4	1	2
Cost of cleaning up CDW in the project site	7	15	17	2	5	1	2
Minor impact							
Purchase of used materials	2	7	7	1	2	0	0

Payment for storage and transport unused materials	4	9	4	0	4	0	2
Payment for disposal of unused materials	3	4	1	1	2	0	0
Cost of cleaning up CDW	3	7	5	1	2	0	2
Cost of cleaning up CDW in the project site	1	4	0	1	1	0	2
Insignificant impact							
Purchase of used materials	3	4	2	1	3	0	0
Payment for storage and transport unused materials	2	6	2	1	4	0	0
Payment for disposal of unused materials	1	5	2	2	3	1	0
Cost of cleaning up CDW	3	7	5	1	2	0	0
Cost of cleaning up CDW in the project site	1	1	2	1	3	0	0
No impact							
Purchase of used materials	1	1	0	0	0	0	0
Payment for storage and transport unused materials	0	0	0	0	1	0	0
Payment for disposal of unused materials	0	0	0	0	2	0	0
Cost of cleaning up CDW	0	0	0	0	0	0	0
Cost of cleaning up CDW in the project site	1	0	0	0	1	0	0

To provide a more comprehensive evaluation we considered the preferences of professionals in each category considering both the significant and major impacts. These findings are summarized in Table 4.14.

Regarding the significant impact of CDW on the economy, most Quantity Surveyors (19) identified payment for disposal of materials as the major impact. Similarly, most contractors (19) highlighted the cost of cleaning up the project site as a major impact of CDW. Overall contractors and quantity surveyors had a higher representation compared to other groups.

The discussions in the following section will delve into an analysis based on these four themes: social factors, policy factors, financial factors and technical factors.

4.12 The Themes

4.12.1 Social Factors

Although many causes of CDW were technical, the significant factor (as shown in Figure 4.8) is the social aspect - "starting construction without complete documentation." Another contributing factor is the lack of collaboration within industry. As mentioned in Section 4.12, the survey scope was guided by existing literature, which limited the range of solutions explored in Section 4.6.

However, failing to address these social causes may lead to any improvements made not having an impact. Considering the state of Nigerian construction industry, it is crucial to implement regulations for waste management to reduce construction waste (Ogunmakinde, Sher and

Egbelakin 2022). Additionally, without fostering a culture we will continue to rely on scavengers who can easily access locations where roads are inaccessible.

Before identifying the factors that drive recycling and reuse efforts it is important to discuss the barriers that hinder these practices. The social factors identified as barriers include concerns about quality of recycled material (ranked fourth with a score of 64.1%) and perceiving CDW as an end of pipe treatment approach (ranked tenth with a score of 26.9%). Unfortunately, due to Nigeria’s prevailing culture that sees waste as mere refuse, then, overcoming this mindset becomes challenging.

Until now this prevailing belief has remained prominent in cities (Olukoju, 2018). To tackle this problem, it is crucial to encourage a shift in perception towards viewing waste as a resource. A recent study conducted by Ogunmakinde, Sher and Egbelakin (2022) put forth a framework for the implementation of circular economy practices in Nigeria. They highlighted that the adoption of circular economy principles is still at a stage within the construction industry of the country. The Nigerian construction sector heavily relies on resources. Faces challenges when it comes to implementing sustainable practices due to limited access to technological resources.

The concept of recycling stems from our desire to transform discarded materials into something useful following the principle of "why waste it if you can recycle it." Ogunmakinde, Sher and Egbelakin (2022) also observed that while reducing and reusing embraced strategies under the 3Rs principle (reduce, reuse, recycle) recycling is less commonly practiced. However, this tendency tends to overlook the significance of recycling as the R. The recycling industry in Nigeria is still in its stages with metal being primarily recycled from construction waste materials. Nevertheless, due to transportation costs involved, scavengers often serve as intermediaries for recycling companies by collecting discarded waste.

To overcome the challenges related to recycled materials and public awareness it is important to understand how drivers, for reuse and recycling can make a difference. According to the majority (78.2%) of respondents' social factors such as providing education to construction workers are highly influential. Therefore, it is recommended that professional and academic organizations educate their members on recycling and reuse practices for construction waste. It is worth noting that with education scavengers currently play a vital role in waste management in Nigeria collecting and sorting materials effectively. This significant contribution has been recognized by 52% of participants, who believe that formalizing the role of scavengers will further promote reuse and recycling in the construction industry. Education plays a role in changing the perception of waste inevitability; however, there is a need to enhance the curriculum, in Nigeria to align with workplace requirements (Salabson, 2019; Fitriyanti Zulaikha et al. 2021; Jiboku, Jiboku and Babasanya 2021).

Here are some social factors that have been identified to improve waste management:

1. Eliminating godfatherism (ranked 3rd with a response rate of 73.5%).

2. Introducing education in waste management (ranked with a positive response rate of 70.1%).

3. Raising awareness about waste management (ranked 6th with a response rate of 63.8%).

The ranked social factor is the elimination of godfatherism and political patronage in the construction industry. In Nigeria important decisions are sometimes made based on politics and connections of capabilities. Participants also suggested waste management strategies such as increasing client awareness and stakeholders' involvement. The significance of education and public awareness has been emphasized in sections.

4.12.2 Technical Factors

Of the 8 identified causes of CDW, 5 are linked to technical factors, with offcuts (58.8%) identified as the primary technical factor contributing to waste generation. The other factors include unused materials and products (48.1%), accidental damage (46.3%), lack of storage space (46.3%), and building design (40.9%). Other contributing factors include materials and products (48.1%)**,** accidental damage (46.3%) limited storage space (46.3%) and building design issues (40.9%). Offcuts refer to scraps, like metal bars, aluminum slides, electrical wires, plumbing components, shutters, railings and gutter remnants. These scraps primarily consist of materials such as wood and metals like steel, iron, copper, and aluminum.

Unused materials can include waste that occurs due to exposure to precipitation before it should or improperly cut wood or plumbing fittings with incorrect sizes or solidified cement. For example, errors in the bar bending schedule can result in an amount of reinforcement bars. Accidental damage refers to damage that may occur during transportation or while storing materials on site. Moreover, engineering mistakes can sometimes lead to demolitions within the construction building based on experiences.

In some instances, the volume of materials supplied may exceed the storage capacity, compelling contractors to store them outside due to a lack of storage space The limited storage capacity available often leads to an increase in waste during periods of rainfall. In Nigeria construction activities tend to slow down during rainy season to mitigate the accumulation of excessive waste. It is important to note that while there are factors that contribute to waste the most significant factor identified is social in nature – starting construction without having all the necessary documents in place.

The proposed measures for reducing waste primarily technical factors with focus on the use of standard material sizes for construction purposes (65.8%). The other options received responses below 40%. In the Nigerian construction industry, there is a prevalence of small and medium scale companies, which could explain why innovative options like construction (21.5%) prefabrication (25.3%) circular economy (22.5%) and design for deconstruction (21.5%) were rated lower.

The adoption of standard material sizes plays a role in minimizing offcuts and thus reducing material waste significantly (with a 58.8% response rate). It is essential to ensure that the use of reusable products is specified for construction requirements, at every stage of the building process.

Digital construction, also known as Building Information Modeling (BIM) plays a role in minimizing material waste optimizing building design, managing storage space and reducing damage. According to a study by Olanrewaju and Ogunmakinde (2020), BIM awareness in Nigeria is primarily limited to the design stage leading to waste when the rest of the industry fails to embrace it.

Large scale companies commonly employ prefabrication as a construction system. This approach helps address waste resulting from storage space and building design challenges. However, its cost implications restrict its adoption within the Nigerian construction industry, which mainly consists of small to medium-sized companies.

Circular economy principles promote the recycling and reuse of existing materials for new construction purposes. Unfortunately, the prevalence of “waste inevitability culture" among Nigerians hinders the robust adoption of circular economy practices. A framework developed by Ogunmakinde, Sher and Egbelakin (2022) highlights that circular economy construction is still in its investigative phase in Nigeria. The concept of designing for deconstruction promotes the use of prefabricated materials and encourages reuse and recycling. However, implementing this approach in Nigeria might require stringent laws and policies (Silva et al., 2020).

The main obstacle to reuse and recycling is the lack of regulations accounting for about 75.6% of the challenges. Others are technical barriers with the key barriers being availability of recycling facilities (65.9%), difficulties in storing and separating materials (58.2%) transporting them to reclamation sites (55.2%) dealing with distances (50.1%) addressing all waste streams adequately (39.8%) finding suitable end of treatment options (26.9%) as well as a lack of accurate measurement by craftsmen (Ike et al., 2018).

In Nigeria, formal recycling systems exist for metal, paper, plastic and glass waste streams as described by Ike et al. (2018). However, most waste recycling activities in the country occur through informal channels. Even though private waste recyclers are involved in household collection in areas like Lagos state, the informal sector still predominantly controls recycling operations, who works closely with scavengers.

The limited public awareness about waste recycling companies, coupled with their limited spatial coverage mainly in major cities like Abuja, Ogun state, Lagos state, Edo state and Oyo state makes the situation worse. This corresponds with the belief of respondents that scavengers play a crucial role in recovering materials as indicated by a response rate of 52%.

To overcome technical barriers to reuse/recycling in the CDW management sector, there are strategies that can be employed. Selective deconstruction (60.1%) provides an alternative to complete demolition by removing materials before dismantling the entire structure. Skip bins (56.5%) make it easier to load onto trucks and are commonly used in residential and commercial areas. It is important to incorporate bins into construction sites as part of a waste management plan. It's worth mentioning that Nigeria's construction industry has caused damage, including indiscriminate deforestation for timber and plywood production as well as excavation of red mud, for ground leveling purposes. To tackle this issue effectively, it is crucial to impose fines and potentially increase the cost of materials to encourage practices and protect the environment.

All the waste management strategies fall under technical factors. Among these, landfilling is rated the highest, at 53.8%, followed by on site reuse at 47.7%. Informal waste disposal, recycling, energy recovery and incineration are also factors at 29.9%, 27.1%, 26% and 23% respectively. Scavengers were rated the least with 22.8% of respondents acknowledging their role.

Landfilling is a common practice in Nigeria; however, it is concerning that there are no engineered landfills in major cities like Abuja and Lagos, equipped with liners to detect and extract leachate (Chimereze, Omokhudu and Ahijo 2016). This raises concerns about groundwater contamination and other environmental impacts caused by leachates. Interestingly Ogunmakinde, Sher and Egbelakin (2022) also observed that landfilling is the waste disposal method in Nigeria followed by on site reuse as backfilling and recycling.

On site reuse ranks second among the listed waste management strategies. Unfortunately, many construction materials used in Nigeria do not adhere to sizes which results in a volume of offcuts that cannot be effectively reused. To ensure on site reuse practices it is crucial to utilize construction materials of size and quality.

Metals are commonly recycled in Nigeria. Broken blocks or rubble are often repurposed as filling material (Nasidi et al., 2018). (Nasidi *et al.*, 2018) investigated potential biomass resources derived from decomposing waste. It is crucial for waste management plans at the local levels to incorporate reuse as vital part of the regulations.

The identified reuse methods are all technical, with the favored method being the use of concrete to fill potholes (63.1%). This is followed by using soil for landscaping purposes (61.9%) timber for formwork (52.4%) offcuts for use (37.8%) concrete as aggregate (28%) reusing metal waste (25.9%) and using wood as mulch (25.9%). The deteriorating condition of Nigerian roads can be attributed to construction quality and excessive weight from heavy duty trucks, which may explain the high demand for concrete refilling. Additionally, there is also a high demand for soil for landscaping in Nigeria.

All perceived environmental impacts related to CDW are categorized as technical with non-biodegradable materials ranking highest among respondents (71.3%). Most construction materials used are non-biodegradable. Consequently, they end up discarded in landfills as mentioned earlier in this section.

4.12.3 Financial Factors

While the methods mentioned for reducing waste may seem technical, it seems that offering incentives could be the key to encouraging changes towards waste recycling and reuse. Abila (2018) have emphasized the potential impact of financial incentives in driving waste reduction. Interestingly financial incentives also ranked second (at 60.9%) as a motivator for promoting reuse and recycling. On the other hand when it comes to recycling, many perceive costs associated with recycling as barriers to reuse and recycling efforts. These extra costs are mainly attributed to Nigeria's underdeveloped recycling market, which ranked as the highest barrier at 68.9% (Abila and Kantola 2013). The construction costs of a conventional material recovery facility (MRF), as indicated in the literature (Olukanni and Nwafor, 2019), could contribute to these additional costs. However, cost can also arise from transportation costs, energy or manpower expenses during processing and challenges faced in operating within an immature market (Olukanni and Nwafor 2019).

These findings align with the understanding that providing resources (81.9%) is crucial in improving waste management practices. Currently waste in Nigeria is not sorted at the point of disposal; hence there are requirements, for sorting and treatment processes.

Moreover, all the factors mentioned regarding the impact of CDW on the economy are related to finances. The significant cost factor is linked to the cleaning up process of CDW at project sites (75.6%). This is followed by expenses for disposing of materials (68.7%), costs associated with cleanup (62.1%) procurement of unused materials (59.1%), and storage/transportation of unused materials (53.6%).

4.12.4 Policy Factors

According to the survey findings, the primary barriers to reuse and recycling are associated with political factors, with insufficient regulation ranking highest (75.6%). This is further supported by comments from respondents commenting on a lack of regulatory bodies visiting sites. These results highlight the weak implementation of waste recycling and reuse laws in Nigeria, along with a lack of oversight from regulatory bodies. One important legal factor for enhancing waste management is the presence of policy interest in CDW (76.8%). This underscores the need for a shift in policy focus towards environmental protection. Additionally, it is crucial for the Nigerian government to improve stakeholder awareness as an integral part of their waste management strategy. By promoting awareness and engagement among stakeholders, progress can be made in addressing the challenges faced in waste management.

4.12.5 Factor Combination

Although the proposed causes of waste and waste management strategies can mainly be categorized as technical factors, it is important to consider the potential impact of social, financial, and legal responses as drivers for reuse, recycling, and overall waste management enhancement. These factors introduce additional complexities that warrant further exploration in future research. However, it is surprising to note that no specific financial and legal causes of waste have been identified, despite the recognition that financial factors play a significant role in improving waste management practices. This calls for further investigation into the relationship between financial and legal aspects and their influence on waste generation and management.

It is crucial to examine how financial incentives, such as financial support or penalties, could affect waste reduction efforts. Additionally, exploring legal frameworks and regulations that promote sustainable waste management practices could provide valuable insights into the barriers and drivers for waste reduction and recycling. Further research in this area would help shed light on the multifaceted nature of waste management and provide a comprehensive understanding of the social, financial, and legal dimensions that contribute to effective waste reduction and management strategies.

4.13 Discussion of Chapter Key Findings

The preparation of the survey given to the participants was initially shaped by existing literature. Upon analyzing the results, it became clear that this approach limited the range of possible solutions. A broader perspective would have been more advantageous. However, the open - ended options within the survey allowed respondents to share their thoughts beyond the scope. These insights influenced the approach to the interviews (Chapter 5) and ethnographic research (Chapter 6). As a result, participants had freedom to express their viewpoints.

Figures 4.1 and 4.2 demonstrate the variety of roles and organizational sizes represented in the study. These figures provide a representation of Nigeria's construction industry especially considering the high proportion of small companies with approximately 100 employees (Ogbu and Olatunde, 2019).

Figures 4.3 and 4.4 revealed that 74.5% of participants were both aware of and concerned about the amount of CDW generated by their companies. However, it is important to note that this awareness does not necessarily imply having a tool to measure its quantity accurately. This point is reinforced in Section 2.3.2 by existing literature highlighting that the exact extent of CDW wastage, in Nigeria remains unknown.

According to a study, by Tam, Soomro and Evangelista (2018) solid waste in Nigeria consists of both construction and municipal waste. Professionals in the construction industry have noted that masonry is the major type of CDW, followed closely by timber/wood products and glass/tiles/ceramics (Figure 4.7). Almost all of the respondents believe that reusing and recycling CDW has potential for managing a significant amount of waste in Nigeria. This justifies the findings of Tam, Soomro, & Evangelista (2018) that reuse, and recycling greatly supports CDW management in the construction sector.

The opinions expressed by the respondents were evaluated based on four themes: social factors, technical factors, economic factors and political factors. These themes provide a framework that can be further refined in the later chapters. The selection of social factors as the first theme highlights the importance of transformation as a prerequisite for reducing waste. In Nigeria there is often a prevailing belief that waste is unavoidable which has impeded efforts to reduce it. Therefore, addressing the aspect of waste management is deeply connected to society. Additionally social factors intersect with expertise, financial considerations, and legal aspects. Technical factors play a role in waste reduction as they involve professionals and technicians actively engaged in implementing measures to reduce waste.

The decision to allocate funds, for waste reduction, in Nigeria depends on the condition of the country’s economy and how policymakers perceive the social benefits of waste reduction initiatives (Tam, Soomro, & Evangelista, 2018).

4.14 Chapter Summary

In a bid to satisfy objectives two, three, four and five, this chapter addresses findings derived from quantitative data obtained through a questionnaire (prepared from literature) and distributed to construction practitioners in Nigeria.

The results shows that the Nigerian construction industry is represented by a particularly high proportion of small-sized companies (with around 100 employees). Figures 4.3 and 4.4 also indicated that majority of participants were both aware of and concerned about the amount of CDW produced by their respective companies, though the exact amount of CDW wastage in Nigeria is currently unknown. The construction professionals who have direct experience indicate that masonry is the major CDW material, closely followed by timber/wood products and glass/tiles/ceramics. The views of the respondents regarding subsequent questions were evaluated across four broad themes: social factors, technical factors, economic factors, and political factors. The selection of social as the first theme aims to emphasize the need for cultural reorientation as a prerequisite for waste reduction in Nigeria.

CHAPTER 5 – PERCEPTION OF POLICY STAKEHOLDERS

5.1 Chapter Overview

The results presented in this chapter support objectives 2, 3,4 and 5 listed below:

Objective two - Analyze current practices relating to reuse and recycling of construction and demolition waste in Nigeria.

Objective three - Investigate the barriers to reuse and recycling of CDW in Nigeria.

Objective four – Identify the drivers for effective CDW management in Nigeria.

Objective five - Evaluate the role of informal waste workers in the reuse and recycling of CDW in Nigeria.

Upon analyzing the results from Chapter 4, it became clear that the survey approach limited the range of possible solutions. However, these insights influenced the approach to the interviews (Chapter 5), with a broader perspective which would be more advantageous as participants had freedom to express their viewpoints.

Hence, this Chapter presents the qualitative responses in relation to objectives 2, 3,4 and 5. Findings from the literature review were integrated with the findings from the qualitative interviews to ensure robust analysis as the basis of the conclusions. The chapter ended with a discussion of key findings.

5.2 Demographic Characteristics of Interview Participants

Data collection stage is crucial for achieving a research goal and objectives as it involves gathering significant information from relevant sources (Fetters, Curry, and Creswell, 2013). As outlined in the methodology chapter (Section 3.4.2), the researcher invited 30 politicians for interviews, and ultimately conducted 12 successful interviews. These 12 participants are politicians who possess professional backgrounds in the construction industry. The purpose of these interviews was to obtain their opinions on topics related to the reuse and recycling of CDW in Nigeria.

Among the 12 interviewees, all of whom were male, there were 5 engineers, 4 quantity surveyors, 2 architects, and 1 building technologist, ensuring an even distribution of professionals. It is worth noting that the participants included academic professors and individuals with PhD qualifications. The minimum qualification among these professionals was a bachelor's degree. The interviewees were chosen to represent two distinct groups: government officials selected through political appointments (2 commissioners for works and housing, 2 directors of state environmental protection agencies, 2 heads of government department in parastatals, and 4 directors from professional bodies), and individuals selected based on their qualifications and years of service (2 environmental consultants). The selection of these policy makers spanned across the country and was based on their familiarity with the construction industry. They were also considered to have knowledge about recycling and waste management in general. This diverse group of participants was chosen to ensure unbiased interview results.

It is important to mention that all participants also work privately as contractors or consultants in the construction industry. Moreover, each participant has diverse and multiple roles and has been involved in multiple projects over the past 15 years. As a result, their extensive understanding of waste management concepts, combined with their up-to-date knowledge and experience in the construction field adds credibility and reliability to their responses. It is worth noting that their positions in governance and their professional backgrounds also influence how they perceive things and shape the outcomes of their responses. The combination of their experience and educational qualifications further strengthens the validity of their viewpoints regarding the objectives of this study. The demographic findings, which provide information about the characteristics of the participants, can be found in Table 5.1. This table accurately represents the sample from the target population without any distortions or biases.

Table 5.1 Demographic information of interview participants.

Interview Participants (abbreviated)	Political roles	Professional roles
1CE	Lagos state waste management authority (LAWMAN)	Civil engineer
2QS	Abia state environmental protection agency (ASEPA)	Quantity surveyor
3CE	Representing professional body (Nigerian institute of civil engineers, Lagos chapter)	Civil engineer
4CE	Representing professional body (Nigerian institute of engineers, Enugu state)	Civil engineer
5 CE	Representing professional body (Nigerian institute of engineers, Anambra state)	Civil engineer
6BT	Representing council of Registered builders of Nigeria (CORBON)	Building technologist
7QS	Representing department, quantity surveying	Quantity surveyor
8QS	Senior quantity surveyor, project Admin &procurement officer	Quantity surveyor
9ARC	Representing department, school of health technology, Abia state	Architect
10ARC	Commissioner for works	Architect
11CE	Representing council for regulation of engineers in Nigeria (COREN)	Civil engineer
12 QS	Consultant resident quantity surveyor at construction company	Quantity surveyor

Abbreviation for professional roles; Civil engineer-1CE,3CE,4CE,5CE,11CE, Quantity surveyor-2QS,7QS, 8QS,12QS, Building technologist- 6BT, Architect- 9ARC,10ARC.

The professional roles of the participants is represented diagrammatically using this pie chart.

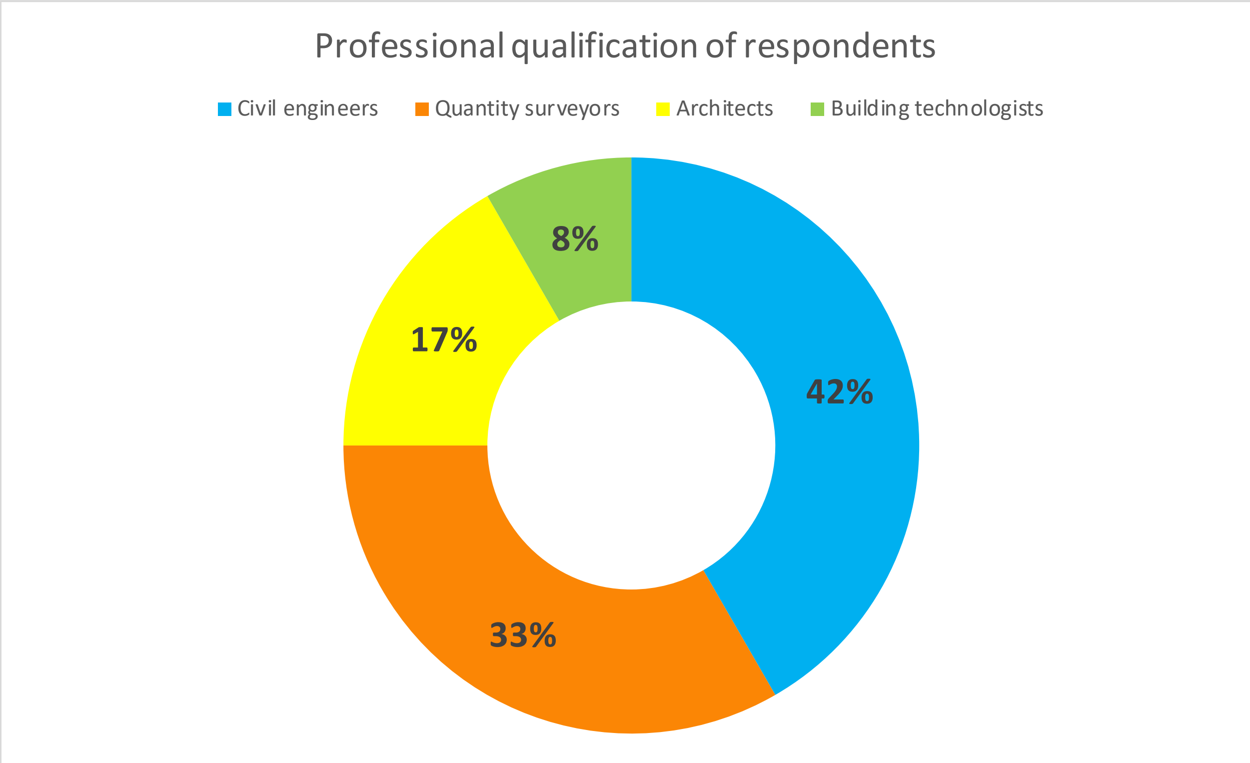

Figure.5.1 Professional qualification of participants

5.3 Data Analysis

Data analysis entails employing established methods to efficiently organize and convey the amount of data gathered during a research study (Fetters, Curry and Creswell, 2013; Alase, 2017). As detailed in Section 3.3.2.2, the interview data was carefully examined using NVivo software. This process involved creating topics that align with the six interview questions. These topics (found in Section 5.4-5.8) were thereafter categorized into the existing four themes (social, technical, financial, and policy factors) (Section 5.9). Below are the interview questions.

- What are the barriers to the reuse and recycling of Construction and Demolition Waste (CDW) in Nigeria?
- What economic incentives support CDW reuse/recycling in Nigeria?

- How can CDW management be effectively implemented in Nigeria?
- What efforts are being made to combat illegal dumping of CDW in Nigeria?
- How can CDW management be further enhanced in Nigeria?
- How can scavengers contribute to the Nigerian CDW management system?

The researcher categorized the responses, and the frequency of each category indicated the number of instances in which it appeared in the data (refer to Table 5.2. The relevant keywords from the interview script were grouped based on their significance. The coding process followed an approach capturing the elements of the collected information. Themes were defined by identifying commonalities among the codes. The developed themes were reviewed to ensure their alignment with the coded excerpts and the entirety of the interview document. Subsequently, each theme was assigned a name. The qualitative research findings were then compared to previous literature review findings, specifically to explore the impact of reuse and recycling of CDW in the Nigerian construction industries. The researcher conducted further literature analysis for each theme, refining the essential elements and elucidating their meanings. The responses were categorized into topics, (each topic represents each question asked), while the chapter key findings were categorized into the initial themes (social financial political and technical themes).

To illustrate the emergence of the themes from the interview data, Table 5.2 presents an example of a coded section. The categories within the table provide a summary of the interviewees' responses derived from the data.

Table 5.2: Visual representation of the results obtained from the NVivo analysis of interviews.

	NVIVO ANALYSIS		
Topics	Categories	No of occurrences	Themes
Barriers to reuse and recycling of CDW in Nigeria	Inadequate regulation/legislation/policy and its implementation	20	Political
	Lack of education (little or no knowledge about CDW management)	13	Social
	High cost of CDW management	10	Financial
	Lack of technology for recycling	4	Technical
	People's lifestyle	4	Social
	Belief and confidence in excess natural resources	3	Social
	Lack of electricity/poor infrastructure	2	Social
	CDW not commercially viable in Nigeria	2	Financial
	Multifaceted and multi elemental construction industry	1	Social
	Lack of tax incentives	1	Financial
	Lack of synergy	1	Social
	Quality of material	1	Social
	Lack of quality control of construction materials	1	Social
	Population growth is a major factor	1	Social
	Quackery in the industry	1	Technical
	Generally, all the CDW produced in Nigeria are reused	1	Technical
Economic incentives to support reuse /recycling	None that I'm aware of	11	Financial
	Only recently in Lagos State	1	Financial
How to make CDW MGT effective in Nigeria	Creating and enforcing policies to encourage CDW management (National building regulation to become a statutory document)	6	Political
	Incentivizing and providing bonuses to construction workers	3	Financial
	Promotion of construction workers	3	Financial
	Revision of building laws	3	Political
	Proper orientation/enlightenment of construction workers and the masses on reuse and recycling	3	Social
	Government and contractors to attach value to construction waste	2	Social
	Improve technical capability and Employing contractors with large capacity (in terms of equipment and technical know-how)	2	Technical
	Government to carry out audit on waste	2	Social
	Government to set up an agency to manage CDW	2	Social
	Professionals should be involved in waste management	1	Social
	provision of basic infrastructures e.g., electricity	1	Social
	Patriotism	1	Social
	Every contractor should have a duly certified environmental manager to handle waste	1	Social
	local council to recognise the need for informal recycling	1	Political
Attempt to stop illegal dumping of CDW in Nigeria	Yes, but the attempts are just discrete attempts, which are not specific to CDW	5	Political
	No attempts	3	Political
	Lagos State in particular, has made attempts to stop illegal dumping	1	Political

	In Anambra State, one can be arrested for dumping waste in an undesignated place	1	Political
Scavengers aid in Nigerian CDW mgt. system	Government should organize all the waste workers (forming association of Nigerian waste workers), provide them with PPE's and provide scavengers with grants in form of financial aids.	24	Political
	Change people's orientation and view of scavengers	2	Social
	Revision of environmental laws to integrate scavengers into formal waste management	1	Political
	Consultants to make allowance for salvage values in their bill of quantities	1	Political
	Giving the right position to the right person to improve competency and good governance	1	Social
	Entrepreneurs interested in waste management to set up businesses around waste workers	1	Social
	Restructuring of the construction industry.	1	Social

Table 5.2: Visual representation of results from NVivo Analysis

5.4 Topic 1 – Barriers to Reuse and Recycling of CDW in Nigeria

The dominant themes in the responses regarding barriers to the reuse/recycling of CDW in Nigeria are related to policy. Numerous other factors, such as financial, technical, and social aspects (including ethical and cultural considerations grouped under social factors), were also significant.

5.4.1 Regulation – Policy and legislation:

Participants highlighted inadequate regulation and lack of policy implementation as strong barriers to the reuse/recycling of CDW in Nigeria. The issue of regulation and policy emerged repeatedly during the interviews, indicating its significance. Participant 6BT explained that while there are laws regulating building construction at the design stage in Nigeria, there is a lack of specific legislation governing the building production processes and CDW management. The national building legislation of the Federal Republic of Nigeria, published in 2006, currently lacks the force of law and has yet to make a substantial impact. This comprehensive legislation encompasses the regulation of CDW, but it requires approval from the Nigerian National Assembly to be enacted into law, a step that has not yet been taken, possibly due to inadequate systems for data management.

Participant 11CE, raised the issue of evolving environmental laws that restrict the reuse and recycling of certain types of waste in Nigeria. In his words, *I think they are still evolving. When one looks at the waste that emanates from building construction, there are different kinds of waste. Some of these wastes, because of changes in environmental laws, are no longer to be recycled. For example, asbestos roofing sheets and similar materials that are toxic. Withs regards to other kinds of waste that are not caught up by changes in environmental laws, e.g., roofing sheets, wood, mortar, blocks, and stones, if we are to look at these wastes one by one, we could see that there is a form of recycling going on.*

Participant 8QS, expressed the view that the implementation of the policy for formal reuse is lagging in Nigeria. According to him, there exists a policy pertaining to formal reuse, but the actual implementation of this policy is lacking. In his own words, *there is actually a policy here in River's state prohibiting dumping of wastes, but implementation is lagging*. The statement suggests that while there is a policy in place to prohibit waste dumping, there is a lack of specific provisions or requirements for promoting reuse. Additionally, Participant #8 mentioned the existence of the Rivers State Environmental Sanitation Authority (RSESA), which was established by an edict from the Nigerian 1999 constitution. The RSESA's primary responsibility is to oversee the contractors appointed by the State Government for the collection and disposal of municipal solid waste. However, effectively managing waste for reuse poses a challenge. The lack of capacity to handle the increasing volumes of waste has been attributed to the changing characteristics of the city, which hosts numerous multinational oil companies in the Niger Delta region of Nigeria and is facing issues of overpopulation (Ogbonna, Amangabara, and Ekere, 2007; Babatunde et al., 2013). This viewpoint aligns with existing literature that states the Rivers State House of Assembly passed the Waste Management Agency Bill into law in 2014. The agency was established to promote environmental cleanliness in the state. However, criticisms have been raised regarding the agency's ability to fulfill its mandated duties (Okoli, Chiamaka Nkiruka, Egobueze, 2020).

Participant 12QS expressed the opinion that participants in the construction industry lack interest in politics, which prevents them from occupying positions where laws beneficial to the industry can be enacted. In the words of participant 12QS, *the right people are not in place to favor the construction industry.*

Another participant, (7QS) made an argument about the expenses associated with waste management. When regulations are not stringent enough, construction companies often choose the cheaper option of discarding CDW materials in unauthorized places. Therefore, it is necessary for companies to perceive the benefits of managing CDW or stronger regulations should be put in place.

Additional research findings emphasize that legislation and waste framework directives play a role in achieving waste management in the construction sector(Kirschke *et al.*, 2019; Aboginije *et al.*, 2020). Many economies are currently developing their waste framework directives to tackle the impacts of waste. For instance, according to a report by the European Environmental Agency, most EU countries have successfully implemented waste frameworks, achieved recycling rates of 90% (Ole Kenneth, 2019). However, Nigeria struggles with implementing national laws aimed at safeguarding public health, environment and natural resources. This weak implementation has resulted in poor solid waste management practices across Nigerian states.

Despite attempts by the Nigerian government to tackle the issue of waste generation and its negative impacts, there are still obstacles that need to be overcome in order to turn this into a tangible reality (Aboginije, Aigbavboa and Thwala, 2021).

5.4. 2 Education

When it comes to education, almost half of the participants (42%) believe that a major obstacle in the construction industry is the lack of awareness and knowledge about the effects of dumping waste in unauthorized areas or landfills. Participant 4CE pointed out that the only effective approach with municipal solid waste is its formal collection. However even though around 70% of it gets collected, it is simply disposed of in designated areas without any recycling plan. This poses a threat to the environment. Moreover, both the government and contractors have limited understanding or awareness about CDW. As a result, when buildings are demolished, contractors tend to discard the waste on roads, landfills or wherever convenient. Emphasizing this issue, 4CE exclaimed: *Yes, we generate CDW all the time, buildings are constantly demolished, roads are reconstructed, but the knowledge about the reuse of these materials is not there at all, there are no existing policies on it.* The main problem lies in people not realizing how important it is to establish a system for managing CDW. Therefore, participant 4CE strongly recommends communication among staff members along with commitment and training as elements for implementing waste management plans.

This aligns with the findings of Aboginije, Aigbavboa and Thwala, (2021) who argue that before implementing waste management practices it is crucial for individuals involved in waste management to have an understanding and recognition of its significance. This also supports the research conducted by Nwankpa, (2020) which suggests that the success of waste management largely depends on the willingness and capability of state leaders to adopt an approach involving service users and residents in policy design, implementation, and evaluation in each state.

Currently, most states in Nigeria lack defined waste management policies. Instead, they rely on ad hoc committees consisting of resident contractors who have limited technical expertise and equipment for waste collection and disposal. This confirms the findings presented in section 2.3.1 indicating that the implementation of these policies often becomes complicated and influenced by certain factors. Further research emphasizes that Lagos state stands out as the state in Nigeria with a waste management policy. This is demonstrated through its integrated waste management scheme facilitated by the Lagos State Waste Management Agency (LAWMA) (Olukanni and Nwafor ,2019). Ezechi et al. (2017) also affirm that solid waste management is considered a low priority in urban areas and cities, across Nigeria.

5.4.3 Cost

In terms of cost, half of the participants believe that waste management expenses in Nigeria are too high and that there is no funding allocated to the construction waste sector. This perception may be due to the constraints faced by the construction industry, which mainly consists of small to medium sized independent enterprises lacking the necessary resources to effectively handle CDW. Participant 8QS expressed his opinion; *Reusing at times, is more expensive than using a new material in Nigeria because the cost of bringing the material to its original value is high*. With regards to these, 2QS argues that waste management in Nigeria has not yet become commercially viable. Despite government investment in handling solid waste, companies involved in CDW lack the financial capacity to manage it effectively. Moreover, he further pointed out that unfavorable economic conditions limit recycling efforts in Nigeria. Participant

10ARC describes this situation as follows; *Our approach to recycling is heavily influenced by challenging realities unlike countries where incentives are provided to encourage recycling.*

Participant 2QS also raises another issue regarding high import duties on recycling plants. Reducing these duties would serve as an incentive to promote and improve recycling practices in Nigeria. However, participant 2QS suggests that banks could offer favorable terms to encourage investments in the field of managing construction waste. On the other hand, some individuals believe that there is a lack of markets for dealing with CDW.

In line with the viewpoint of 2QS, participant 7QS also argues that the recycling industry in Nigeria is still in its stages of development. The level of industrialization in the country remains relatively low. Often it is cheaper to import goods than produce them domestically. These diverse perspectives, predominantly expressed by quantity surveyors highlight the importance of cost as a factor in establishing management practices for CDW in any country.

5.4.4 Lack of synergy with construction professionals

Participant 6BT raises concerns, about the lack of collaboration among construction professionals in Nigeria. Despite the expectation that the different building professions in the country should work together they often operate independently even though constructing a building requires an effort from everyone involved. According to 6BT; working *in Silo, in fact, has been an obstacle for the construction industry and without synergy and collaboration things will continue to deteriorate. Construction industry generally in Nigeria is multifaceted and multi elemental and it has its own peculiar problems.* This perspective aligns with 11CEs viewpoint, as an engineer, he believes that although some level of construction waste management exists it is carried out in an ad hoc and disorganized manner. It is worth noting that participants' professional backgrounds can influence their perspectives on this issue.

5.4.5 Lack of Value for construction waste

Participants 3CE, 4CE and 7QS all agree that the problem is the lack of value placed on waste and waste recycling. Participant 3CE specifically stated that; *the government itself do not recognize the wealth in waste.* There is no assigned value to every demolished infrastructure. The contractor in charge decides what happens with the waste from demolition. These perspectives support 4CEs claim that both the government and construction participants do not understand the potential value of waste and its negative effects. Additionally participant 7QS expressed disappointment saying that people don't place any importance on waste materials. Therefore, there is a need for reorientation to attach value to waste materials so that proper reuse/recycling can be implemented. However participant 5CE holds an opinion that people in their area are aware of the value of waste. They stated, *"Because everyone around knows the value of waste and someone there has a need, for that rubble you will see them coming to negotiate for it at a price."* These responses may be influenced by a participant's' professional and political background.

5.4.6 Confidence in the abundance of natural resources

One of the obstacles, to management of CDW as identified by Participant 7QS is the perception of abundance of natural resources in Nigeria such as crude oil, limestone, tin, copper etc. The argument is that due to the country's wealth in resources there is a tendency for people to undervalue waste reuse. However, those who recognize the importance of waste see it as an opportunity for deconstruction and selling materials for profit.

For example, in Kano State the Kano Panteka Market serves as a hub for trading scrap metal materials. Similarly in Abuja the Gwarimpa Panteka Market is where recyclable waste materials are bought and sold. These markets can be seen as colonies of scavengers with over 1,089 registered individuals engaged in buying and selling reusable waste metal materials. The market functions like an organized manufacturing company with departments and specialists. All categories of waste workers can be found within these markets. Scavengers collect metal scraps from the streets, bring them back to their colony where others sort and repair the materials before loading them onto trucks or acting as intermediaries, between tinkers (repairers) and loaders (transporters). These intermediaries buy goods from scavengers by weighing them and act as middlemen who sell these items to recycling companies.

Unfortunately, the prices of the scavengers' goods are determined by middlemen. Depending on market forces a kilogram of scrap can be sold for 1,500 Naira (£2.50) whereas these middlemen resell the materials to companies at higher prices. The scavengers play a role in contributing to government revenue by selling their products to recycling companies, which subsequently generate income for the government. Manufacturing companies that engage in these recycling activities are situated in parts of the country, like Kano, Jos, Kaduna, and Lagos states. However, their existence is being threatened by the Abuja Environmental Protection Board (AEPB) as it aims to eradicate scavengers within the capital territory.

5.4.7 Quackery

One of the concerns raised by the participants is the presence of quackery within the construction industry commonly known as "Cowboys" in the UK. While a few participants mentioned this issue it has become a problem impacting the Nigerian construction sector. Participant 6BT shared their perspective on this matter expressing disappointment that quacks have infiltrated the industry and developers seem to prefer them over professionals. This has become an issue. Another point raised by 9ARC is the lack of discipline among contractors. He opined that there is a lack of motivation to do what is necessary; *the urge to do the needful is not there. Professionals in environmental waste management should be involved instead of allowing quacks to handle waste or every contractor should have a duly certified environmental manager to handle waste.*

5.4.8 Lifestyle

Moreover, a common stereotype exists in Nigeria regarding waste management, where people have developed a habit of disposing of waste in various places. These locations include waterways, empty lands and roadsides. This behavior can be attributed to a lifestyle that emphasizes the pursuit of luxurious items. One participant, 7QS accurately captures this sentiment; *When the client is wealthy, they feel ashamed to reuse waste materials due to judgment, so they prefer everything to be brand new.*

Participant 8QS also provides an example that aligns with the point; *For instance, no consultant would be pleased to discover that recycled formwork or reinforcement was used in a building even though they understand that what truly matters is the result and not the formwork itself.* The client may even question the stability of the structure solely based on the use of recycled/reused materials. There seems to be a lack of faith and confidence in Nigeria when it comes to recycled materials lasting for a long period. In Nigerian culture, there is a prevailing preference for everything being brand new. This finding is consistent with the insights mentioned in section 2.3.3. which highlights how salvaged materials from demolished buildings are often disregarded or seen as valueless.

Consequently, contractors receive payment exclusively for removing the CDW from the construction site. However, the economic downturn has inadvertently led to outcomes by motivating individuals to embrace the reuse of construction materials. It is important to consider that participants' professional backgrounds might shape their viewpoints and reactions regarding this issue.

5.4.9 Reuse is a reality.

Participant 5CE argued that CDW produced in Anambra State are generally reused. In his words, he said*: for example, if I have broken blocks/rubble and gather them in a place, people will start coming for it, I even must guard them to prevent theft. Because everyone around knows the value of that waste and someone out there has a need for that rubble, and you will see them coming to negotiate for it for a giveaway price. So, the idea of dumping CDW is not feasible in this area as far as I'm concerned because waste is wealth here and we all know it. If you don't need it, someone does! It is being reused but informally. This is because people around here don't depend on government to provide essential infrastructures. They tend to do everything for themselves and having known the value of waste, it is difficult to see it thrown away. The piece of iron rods left after construction is used by welders for fabricating burglary proofs, used cartons reused as ceiling boards in houses, the concrete rubbles is re-bagged in used cement bags for erosion control as you are aware of the topography of the state, the cement bags are resold for packing sand, stones, (for those that sell in small quantities/retailers, used timber are quickly stolen or sold off as firewood (some people ar of the opinion that food cooked with firewood tastes better),etc. Government cannot manage what someone else has initiated, therefore CDW is produced and managed effectively by individuals in this part of the country. So, the idea of formal waste management is not feasible.*

The adoption of the reuse approach can be attributed to the ongoing construction and modernization agenda implemented by the current government in Anambra state, located in the eastern part of Nigeria. Participant 7QS believes that people from this region demonstrate exceptional ingenuity and resourcefulness in finding ways to overcome challenges. He further states: '*This is one of the reasons why the poverty index in Anambra state is low'.* In these regions, craftsmanship and traditional techniques are deeply ingrained in the way of life and heritage, and the people here have a keen understanding of the economic value of CDW. Anambra state has implemented a new housing policy that involves demolishing properties constructed on waterways as part of an agenda to reclaim the environment (Ugonabo and Emoh, 2013). Consequently, the CDW generated from these demolished houses is managed through informal means.

Globally, it is widely recognized that waste management is essential for fostering a sustainable construction economy. This involves engaging expert builders to minimize and control waste generation (Aboginije, Aigbavboa, and Thwala, 2021). In fact, Aboginije et al., (2020) cited an example where nearly 80% of all waste streams produced on a construction site were found to be reusable and recyclable.

5.4.10 Barrier to reuse/recycling summary.

The barriers to reuse/recycling of CDW derived from Sections 5.4.1- 5.4.9 are summarized and presented in Figure 5.2. The range of topics have been themed in relation to social, financial/cost, policy/regulation and technical factors.

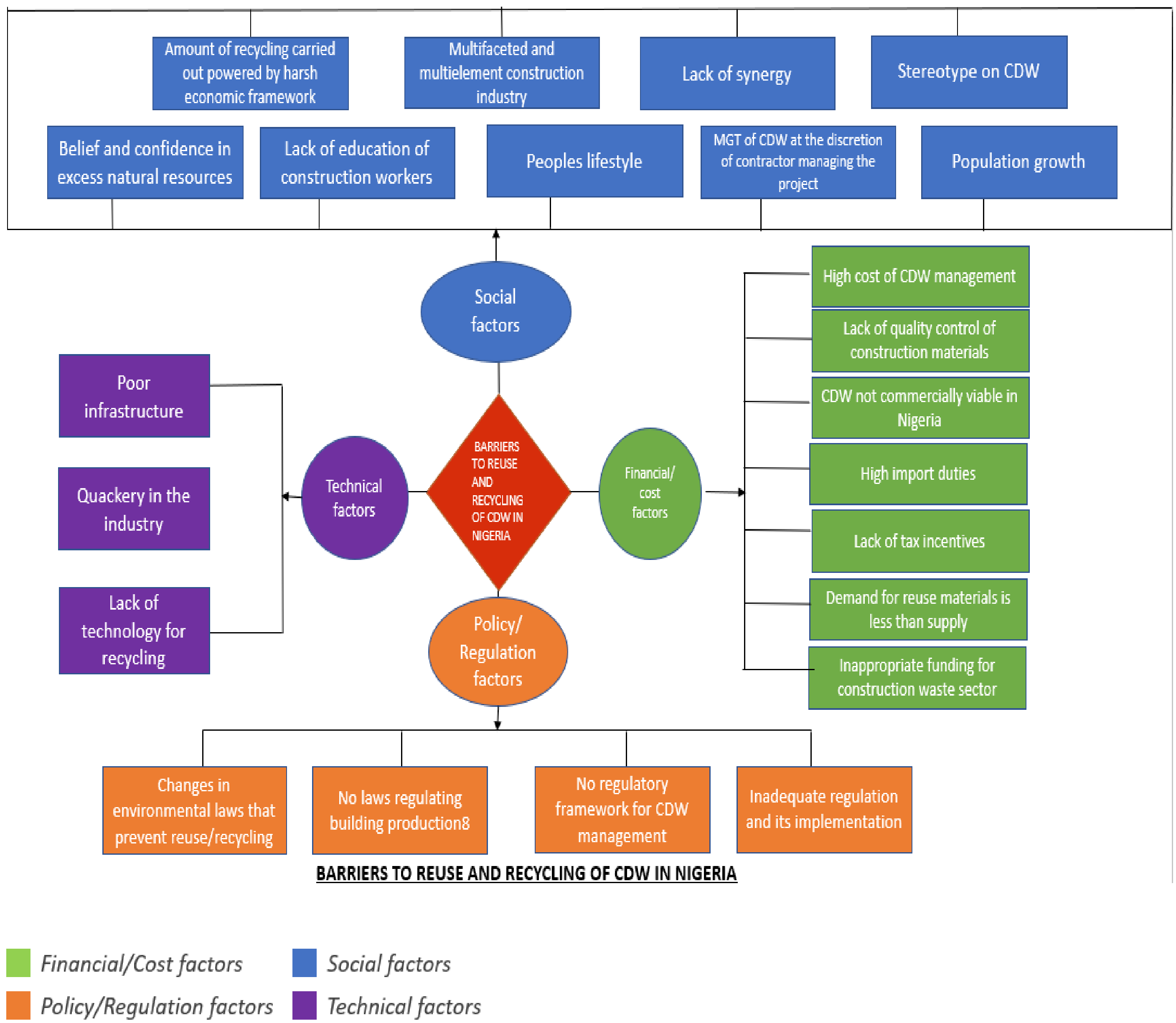

Figure 5.2 Barriers to reuse and recycling of CDW in Nigeria

5.5 Topic 2- Driver for effective CDW Management in Nigeria

Ideas around making CDW effective focus on improved policies and enforcement—providing training and increasing awareness among construction workers through vocational training, as well as incentivizing them.

5.5.1 Improved policies and enforcement

42% of the participants suggested creating and enforcing policies to encourage CDW management. In line with this, Participant 7QS suggested that local legislation should recognize and support informal recycling for sustainable CDW management.

5.5.2 Raising awareness/providing training of construction workers.

Participant 3CE suggested providing awareness/vocational training to construction workers. In support to this, participant 1CE had this to say; *If government or professional bodies can organize workshops or seminars for construction companies on the effective way to handle construction waste. This will also aid in proper handling of CDW*. Some suggested proper orientation or enlightenment of construction workers on reuse/recycling (participant 1CE,4CE, and7QS). Others suggested that the government should carry out an audit on waste and therefore educate the masses.

5.5.3 Incentivizing construction workers

92% of the participating policy makers expressed the opinion that economic incentives are currently lacking to support reuse/recycling efforts in the country. Some suggested promotion and providing bonuses to construction workers. According to participant 9ARC, "*The government should pay scavengers for picking and bringing in the waste materials. What we have here is people paying the government for waste (e.g., ASEPA Levy for waste disposal), the reverse should* *be the case where the government should instead pay construction workers for bringing in waste materials. For instance, if I have waste materials generated from my construction site, the government should pay me for putting them together and bringing in my waste for recycling".*

However, participant 1CE stood as an exception to this view. He was aware of economic incentives specifically in place in Lagos. In his words: *we have started such in form of removing tax waiver for small recycling companies and in return, they provide capacity training for people who are interested in waste picking, we provide security for the personnel's carrying out the recycling, community awareness on recycling (townhall meetings to sensitize people).*

This aligns with literature review findings in Section 2.6.7, which indicate that many developing nations, including Nigeria, lack the financial and technological resources necessary for effective waste management. This can be attributed to inefficient CDW storage at the point of generation and inadequate collection services (Braz *et al.*, 2011; Salami *et al.*, 2019). Consequently, the nearest open spaces, such as waterways, empty lands, and roadsides, become the destinations for CDW in these countries (Mudashiru *et al.*, 2016; Naibbi and Umar, 2017). Further research reveals that the Nigerian government generally does not provide direct financial support to companies but focuses on creating policies that facilitate their growth and smooth operation. However, there are active waste management authorities in Lagos and neighboring Ogun State in Nigeria (Naijalink Limited, 2021). In contrast, governments and financial institutions in many other countries actively support waste recycling companies through funding, tax incentives, and waivers. In Lagos State, the financing of the interviewed recycling companies relied on 70% equity financing and 30% from financial institutions, with no significant incentives comparable to those in other countries.

Following the collapse of the Nigerian steel sector, the supply of scrap metals has been sustained through scavenged scrap. All scrap iron is being recycled in rolling mills to produce iron bars for civil engineering construction, with some exports to countries like China and Turkey (Abd'Razack *et al.*, 2017). Nigerian corporate bodies and individuals are also establishing and promoting initiatives for increased recovery of recyclable materials. Examples include the recycling project at the University of Lagos, which provides monetary incentives for the return of plastic bottles, and Wecyclers, a company engaged in the collection of recyclable materials from low-income areas of Lagos State, which employs an incentive-based approach to promote recycling in Nigeria (Abd'Razack et al., 2017).

These insights enhance the information provided in the literature review (Section 2.6.3), which emphasizes the funding challenges faced by waste management in developing countries. It reveals that local government actors responsible for implementing waste management laws often do not receive sufficient funds to carry out their roles effectively.

Provision of incentives have proven effective in increasing municipal recycling, Therefore, creation of incentives have the potential to benefit reuse/recycling of CDW in Nigeria.

5.5.4 Improving technical capability.

17% of the participants suggested making recycling viable i.e., provision of recycling equipment. Here, participant 2QS sighted an example with regards to recycling*: Today in Nigeria, materials like metal have places where they are recycled. That is why you see scavengers focusing on picking metal waste to take to recycling plants.* In Nigeria, scrap metal is primarily collected informally by scavengers. These individuals visit dumpsites and landfills to selectively gather reusable metal scraps, effectively and efficiently moving from one part of the city to another in search of valuable metal parts. As a result of their diligent efforts, the cityscape remains relatively free of litter. The sale of metals is determined by weight, with one ton of scrap metal typically fetching a minimum of 35,000 to 40,000 naira (£61.00-£70.00). A full truckload of scrap metal can command prices ranging from £615.00 to £702.00. Additionally, copper is valued at a minimum of 5,064,000 naira per ton (£5,900), while a ton of aluminum can be sold for approximately #130,000 (£228.00).

Regarding the infrastructure barrier highlighted in Section 5.3.2, Participant 2QS suggested the provision of essential facilities such as electricity. Furthermore, Participant 7QS proposed the employment of contractors with significant capacity in terms of equipment and technical expertise to help address the issue of quackery discussed in Section 5.3.4.

However, Participant 4CE, a civil engineer, expressed the need for further research on the reuse of CDW beyond its current application in road construction. In his word; *for instance, when re-asphalting roads, for instance here in Benin city, we encourage cold milling (mix it with any other material) before re-asphalting. We mix it and stabilize the sub-base of the road and the base course as the case may be*.

Figure 5.3 represents policy stakeholders' view on drivers for effective CDW management in Nigeria.

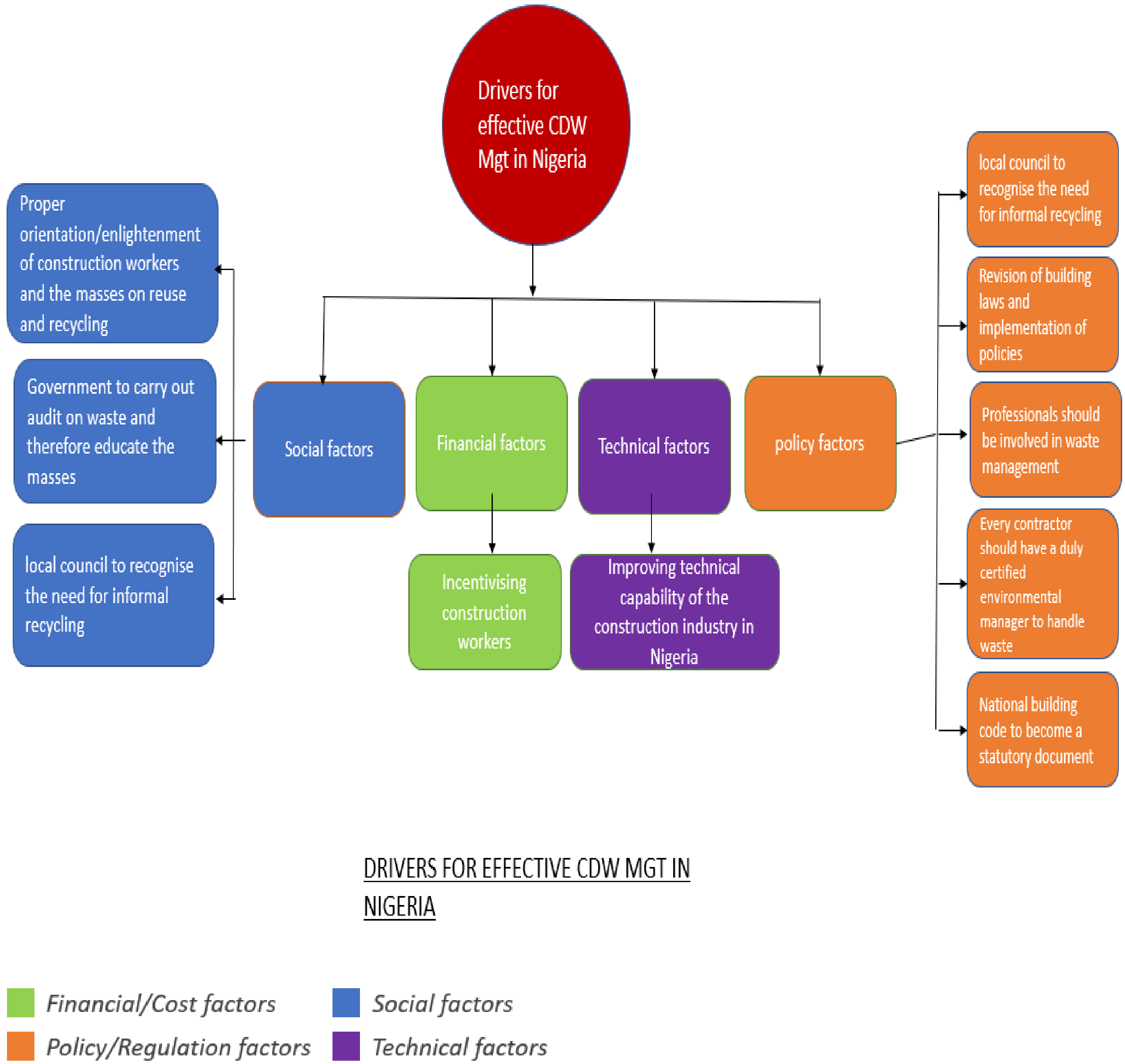

Figure 5.3: Participants view on drivers for effective CDW management in Nigeria.

5.6 Topic 3 - Attempts to stop dumping of CDW in Nigeria

42% of the participants strongly believe that the efforts made to reduce the dumping of CDW are not specifically targeted towards CDW, but rather seen as isolated attempts. This aligns with previous discussion in review of literature, Section 2.2.6.6, which emphasizes the challenges faced by contractors when it comes to enforcing legislation in developing countries. The findings from these studies also acknowledge that private contractors in Nigeria struggle with adopting construction knowledge (Manda and Dhaou, 2019).

Interestingly 25% of the participants expressed their belief that no attempts are being made at all to address this issue. However Participant 1CE confirmed that Lagos State has indeed taken some steps to combat CDW dumping. In his words, *"The state's efforts are noticeable here in Lagos State. They seem to be more effective in areas like Lekki but so in the suburbs."* Furthermore, he supported his point by stating; *"I think it's because council members representing those areas have connections with the state government compared to areas where waste management is not as efficient. Some might call it 'godfatherism'."*

Participant 5CE shared his experience practicing in Anambra State, stating that individuals can face arrest, for disposing of waste in locations.

Participant 8QS suggested a solution to address the problem of dumping of CDW. He revealed that though there are designated places for waste disposal construction companies often see CDW as worthless and make their decisions about how to dispose it. In his words: *forming an agency that will monitor the entire construction companies within the state, who will make sure that all CDW produced will be known to this agency for assessment as well as their recycling.*

Figure 5.4 captures participants' opinion on attempts to stop illegal dumping of waste in Nigeria.

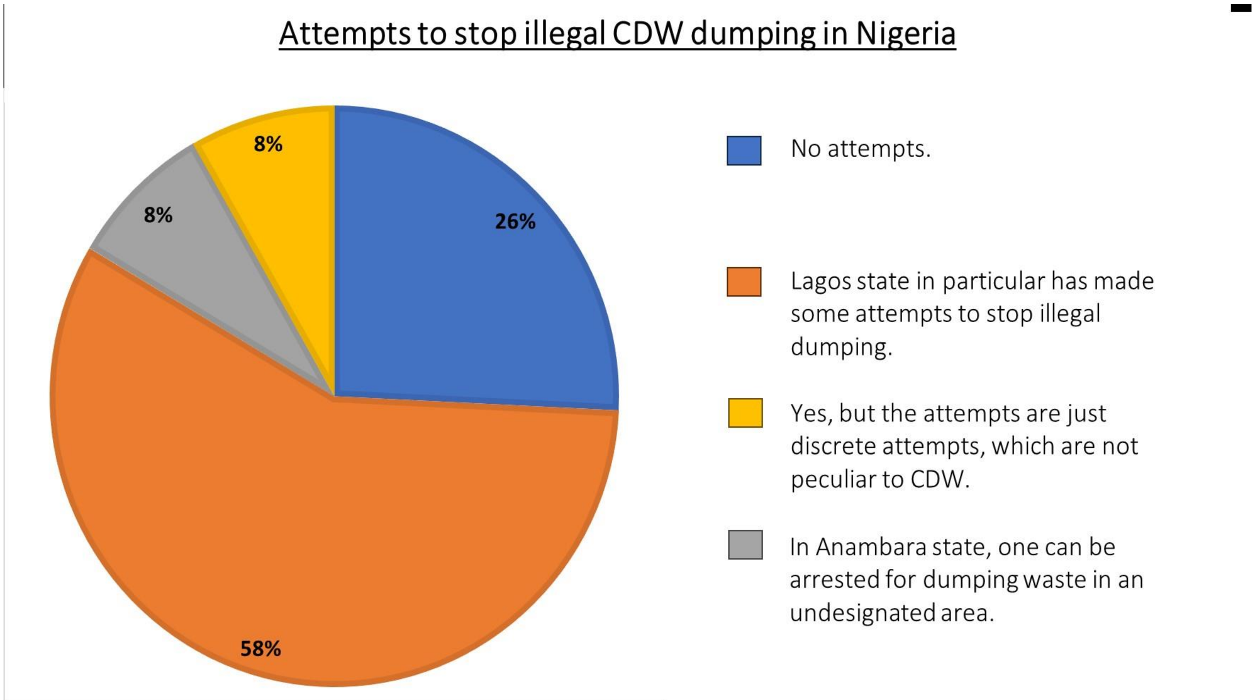

***Figure 5.4 Participants opinion on attempts to stop dumping in Nigeria*.**

5.7 Topic 4 - Policies to enhance CDW management in Nigeria.

Participants provided suggestions, on how to enhance the management of CDW in Nigeria. Participant 6BT recommended implementing policy changes to tackle the issue.

Additionally Participant 7QS emphasized the importance of educating the public and keeping them informed about waste management practices. They highlighted the significance of promoting sustainable development and adopting sustainable approaches to construction waste management. According to participant, 7QS*; it is crucial for us to adopt a mindset where we reuse construction waste, and everyone should be knowledgeable about this approach. Institutions such as NIA, NIQS, NITP, NIESV, etc. can play a role in educating construction stakeholders. Perhaps the government may not fully recognize its value. These knowledgeable institutions can advocate for its recognition by the government.*

5.8 Topic 5 - Scavengers aid in Nigerian CDW management system

After acknowledging the role played by scavengers in waste management, participants were requested to express their viewpoints regarding methods of integrating scavengers into the waste management system in Nigeria. They presented the following recommendations.

5.8.1 Government intervention

A significant majority, 83.3% of the participants, suggested that the government should take certain actions to involve scavengers in the Nigerian waste management system. Their recommendations included providing them with personal protective equipment (PPE), granting them tax relief, and offering financial aid in the form of grants.

42% of the interviewees argued that the government should provide vocational training through workshops, seminars, and research to enhance effective management of CDW.

17% of the interviewees believe that bringing awareness of informal waste workers to the government's attention and providing infrastructure for them is a crucial step.

17% of the participants advised the need to form an agency that will directly absorb or partner with waste pickers to utilize their knowledge about waste (formalize their existing market).

Participant 2QS suggested that scavengers should be educated on the waste segregation. Participant 3CE suggested that there is a lot to be done in terms of legislation, quoting his words; *The Nigerian government have not yet understood the importance of scavengers, most of the environmental laws should be revised to include/integrate the scavengers into formal CDW management. The federal government through the ministry of work can make it a policy to include* *the scavengers in the waste management sector by creating a department for them and as well better their working conditions.*

17% of the participants advised on the importance of changing people's orientation with regards to the way they view scavengers. In the words of participant 6BT, *We Nigerians have this conception about them as dirty people in the society. Until we change the orientation and mindset about them…because if you look at this people, without them, the ecosystem will not be complete.* These findings further strengthen the conclusions presented in Section 2.6.8, which highlighted the case of Bangalore, India. In Bangalore, the waste management law was revised to incorporate and involve the informal sector, including scavengers who were previously marginalized. The study by Gunsilius et al. (2011) also suggests that integration can be facilitated by increasing the awareness of policy makers regarding the activities and contributions of scavengers.

Participant 8QS emphasized the significance of scavengers in the waste management chain, underscoring their importance; *they are so important in the waste management chain as they collect and convert waste to wealth, so if government can absorb them, give them proper training, they will do more and as well realize their self and business worth. I think the government started this in Lagos state where we have the Lagos state waste management board. The entrepreneurs I mentioned earlier have vowed to continue with their waste business as there is so much wealth in it. Just because we have abundant crude oil, the government cares less of waste. They don't seem to realize the wealth therein.*

Furthermore, scavenging provides significant environmental benefits. Recycling materials through scavenging conserves energy and water while producing less pollution compared to obtaining virgin materials (Ayodele, Alao and Ogunjuyigbe, 2018). It also contributes to the conservation of landfill space and reduces air pollution resulting from fewer dump trucks. These points expand on the considerations discussed in Section 2.6.1, which primarily emphasized the need for special initiatives to protect the interests of scavengers, promote sustainable waste management in Africa, and reduce the environmental impact and cost of waste. Previous research has shown that involving stakeholders in government initiatives plays a role in achieving these objectives (Abdelhamid, 2014; Luu *et al.*, 2021).

Participant 4CE referred to scavengers as rescuers – he emphasized their essential role in waste management; *They rescue parts that the government may overlook by collecting and reusing these waste materials*. He suggested that the government should collaborate with them. These findings align with the conclusions outlined in Section 2.6 which highlight how the informal sector in developing countries contributes to cost savings in waste management budgets leading to increased recovery of waste. This aligns with literature findings by Amadi and Chijioke (2018) who discovered that despite their economic status scavengers make significant contributions both economically and environmentally. Not only do they assist in reducing waste, but they also supply raw materials to recycling industries while saving local councils money on waste transportation and disposal. Overall, this positively impacts both the economy and the environment (Section 2.6.2). These findings are consistent with Ogwueleka's research indicating that 40% of artisans and small-scale industries located in Onitsha, the capital of Anambra state acquire 48% of their raw materials from informal waste collectors (Ogwueleka, 2009).

This indicates that even though scavengers may have limited education, they possess strong business acumen and recognize the profitability of different types of waste. Recent studies also show that informal recycling can be a venture, with recyclers earning more than the wage in Nigeria (Amadi and Higham, 2016).

Participant 7QS recommended that construction consultants should include salvage values in their bill of quantities acknowledging the value of materials that can be reclaimed from CDW.

On the other hand, Participant 10ARC presented a different viewpoint suggesting that instead of completely taking over the existing market of scavengers, the government should formalize their roles. According to this perspective the role of the government should focus on regulating than fully controlling this business. In the words of participant 10ARC, *"I believe there is potential for government intervention by formalizing their market, similar to Asa Nnentu market in Abia State where used motor spare parts are sold, we can also have such for reuse CDW market".*

Participant 11CE proposed that entrepreneurs interested in waste management should establish businesses centered around engaging and empowering waste workers. This suggestion highlights an opportunity to create sustainable business models within the waste management sector while involving and uplifting waste workers.

Participant 12QS suggested a need for restructuring Nigeria's construction sector. This suggestion acknowledges the significance of addressing systemic problems and transforming the entire industry to enhance waste management practices. Moreover, literature search uncovered information specific to Aba, where there are over 600 registered informal waste pickers/scavengers, both men and women. These individuals collectively engage in recovery and recycling activities within the state. Despite the crucial role they play, they have not yet been officially recognized as stakeholders in waste management by formal bodies such as state waste management boards. Unfortunately, they often face contempt and disregard (Ezechi et al., 2017; Nwankpa, 2020). This highlights the need for acknowledgment and involvement of waste workers in formal waste management systems.

5.8.2 Forming an association of informal waste workers.

83.3% of the participants recommended that the government establish an organization for waste workers in every Nigerian state. The purpose of forming these associations is to bypass middlemen. Instead, provide payments directly to cooperative members, including those involved in sorting, cleaning and compressing recyclable materials. This approach aims to increase income levels and enhance living standards for the members.

Participant 8QS further supported this suggestion by highlighting the exploitation faced by waste pickers at the hands of middlemen who possess an understanding of the value of waste materials. Due to their vulnerability and poverty, waste pickers/scavengers often sell their goods at prices enabling middlemen to reap most of the profits. Although scavengers are typically part of populations with low incomes, they can earn decent wages when not subjected to exploitation by these intermediaries/middlemen. Research findings also indicate that the low income earned by waste workers can be attributed to the prices paid by middlemen (Rosaldo, 2022). This form of exploitation is prevalent in countries, with waste collection systems where waste workers encounter markets dominated by a single buyer (Medina, 2011; Ezeah, Fazakerley and Roberts, 2013; Nyathi, Olowoyo and Oludare, 2018).

In Nigeria, this anticompetitive market is often observed in dumpsites where waste workers face isolation, making it difficult for them to transport their materials to selling points. Additionally end users frequently collude with middlemen to drive down the prices of the scavenged materials. Unfortunately, many countries have actually legalized market systems leading to the exploitation of waste workers. For instance, in some cities in Mexico, India and Colombia, waste workers receive little as 5% of what industries offer for recyclable materials while middlemen make significant profits (Gunsilius et al., 2011; Medina, 2011).

Consequently, the income of waste workers falls below the wage threshold. Therefore, improving the working and living conditions of waste workers involves finding ways to bypass middlemen—an approach that also applies to scavengers.

To ensure a supply of materials, industries in developing countries often support and encourage the presence of waste dealers and middlemen. However, this arrangement also creates opportunities, for exploitation since scavengers are compelled to sell their materials to middlemen who then sell them to manufacturing industries. These industries typically require the materials to be sorted cleaned, crushed and baled - a process that is usually carried out by these middlemen.

Further research indicates that there have been efforts, in Asia and Latin America, to promote the establishment of cooperatives for scavengers (Hettiarachchi et al., 2018). A successful example is the implementation of network governance, which encourages the participation of both public entities through private partnerships (PPP) in managing solid waste. One instance of this can be seen with EMAC-EP, a waste management company in Ecuador (Hettiarachchi et al., 2018). Similar approaches could be applied in Nigeria by forming associations for waste workers. The objective would be to bypass intermediaries. Instead provide payments directly to cooperative members who are involved in sorting, cleaning, and packaging recyclables. This approach is expected to enhance income levels and improve living standards for these members.

Participant 6BT expressed the belief that once such an association is formed it should be presented to the government as evidence of the role played by these workers in society and the environment. This in turn would encourage the government to offer support and a sense of inclusiveness. In the participants' words, *I strongly believe that it is up to professionals working in construction to take* *on this challenge and create opportunities for waste workers so that they can find their place within society due to their contributions.*

Figure 5.5 represents informal waste management in Nigeria.

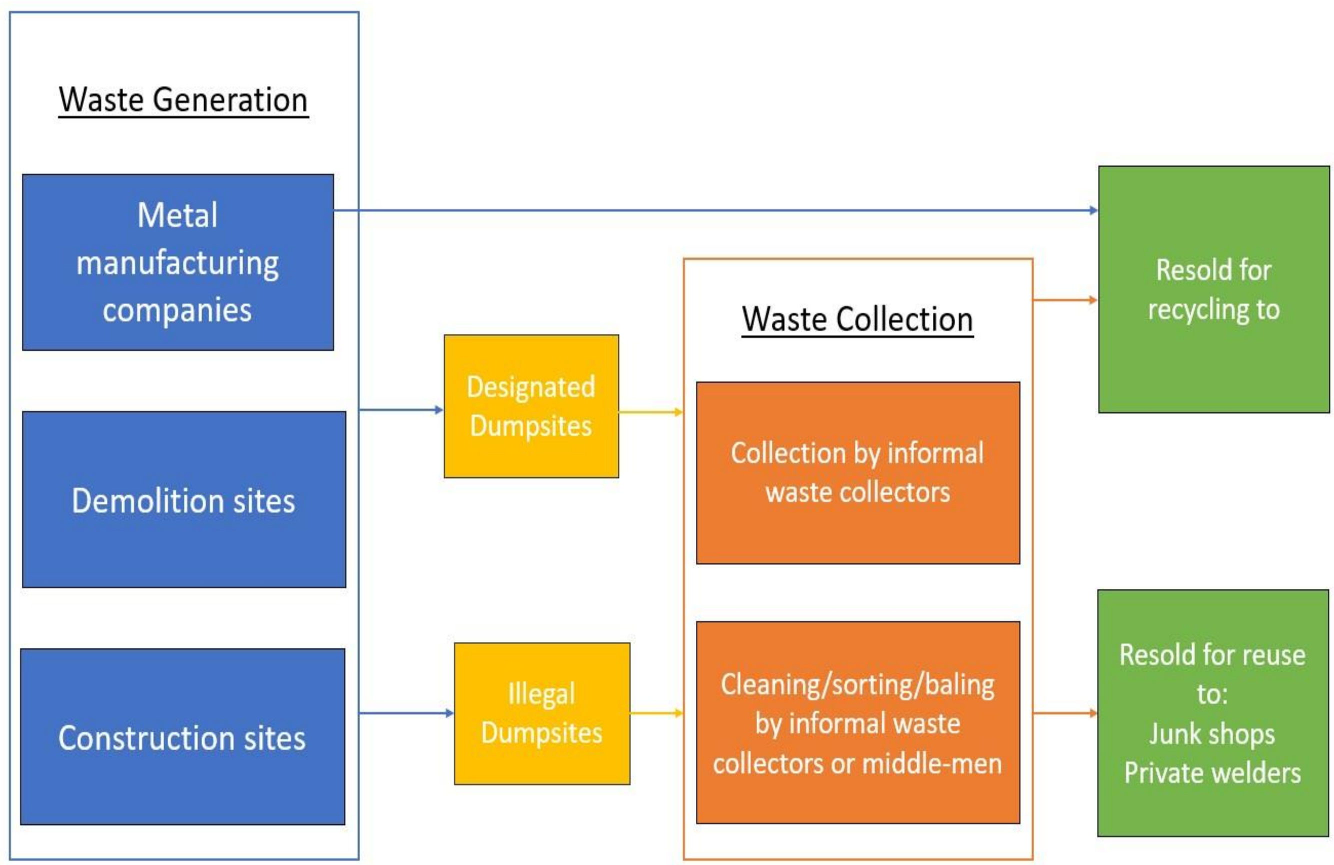

***Figure.5.5 Process flow diagram of an Informal CDW management in Nigeria*.**

5.9 Discussion of Chapter Key Findings

The discussion of the chapter key findings followed a pattern as discussed in the previous chapter. This was equally discussed using the four themes – political, social, technical and financial factors. Table 5.2 contains the identified themes for each category, used for analysis, presented in Sections 5.9.1- 5.9.4.

5.9.1 Political Factors

Most issues related to CDW in Nigeria are believed to be connected to factors including policy and policy implementation. Section 5.2 delved deeper into this observation while exploring the barriers to reusing and recycling CDW. Participants consistently pointed out that inadequate regulation and poor policy implementation are obstacles to CDW reuse and recycling in Nigeria, with an emphasis on this issue appearing 20 times throughout their responses. When there are no laws governing CDW management or when regulations for the design stage of buildings are not applied during the production stage, CDW remains unmonitored during production. This highlights the need for a legal framework and effective implementation as the basis for restructuring the Nigerian construction industry. The key regulatory concerns highlighted by participants include:

- Inadequate regulation
- enforcement of policies regarding CDW in Nigeria
- proper organization of all waste workers including scavengers

Moreover, when discussing how to make CDW management effective in Nigeria participants placed significant importance on regulation. This suggests that successful CDW management in Nigeria primarily relies on measures and ensuring policy implementation. Effective enforcement of laws related to protection and on-site waste management is crucial, for Nigeria.

Furthermore, there is the need to revise the existing laws, at both local and countywide levels, and grant authority to local councils to enforce waste management practices. Although waste management is primarily a concern the implementation of laws in Nigeria tends to be centralized at the state level. Dealing with the issue of waste dumping requires a coordinated effort but unfortunately only a few states in Nigeria have taken steps to implement measures against it. Implementing well executed legal measures would significantly enhance the management of CDW in Nigeria.

In terms of combating dumping of CDW, participants emphasized the importance of regulation, citing efforts made by Lagos State as an example. It was also observed that individuals can be prosecuted for disposing waste in designated areas in Anambra State. This highlights that clear regulations and effective enforcement play a role in curbing dumping activities. Therefore, regulation stands out as a factor in managing CDW across Nigeria.

When considering the contribution of scavengers to CDW management in Nigeria participants strongly expressed their desire for the government to organize all waste workers. This could be achieved by establishing an association for waste workers that provides benefits, like protective equipment (PPE) and financial assistance.

5.9.2 Social factors

According to the participants, one of the challenges hindering the reuse and recycling of CDW in Nigeria is a lack of education. This issue was thoroughly discussed, mentioned 13 times and highlights the limited knowledge about waste recycling and management in Nigeria. The Nigerian education system does not adequately emphasize waste management awareness starting from primary schools. Therefore, it is crucial to sensitize and educate the population on this matter as suggested by Participant 3CE in Section 5.3.2.

It is also important to provide training on waste recycling for construction workers. This can be achieved through initiatives like "toolbox talks." This suggestion aligns with Participant 2QSs recommendation for the government to conduct waste audits and educate the public.

Other social barriers to CDW reuse/recycling include people's lifestyles, a belief in abundance of natural resources, inadequate or poor infrastructure, the perception that CDW treatment lacks commercial viability and the complex nature of the construction industry. Participants 7QS and 8QS discussed stereotypes related to waste disposal practices such as dumping waste in areas and a preference for materials over recycled ones. Participant 8QS even mentioned that clients may doubt the stability of buildings if recycled/reused materials are used.

Many people, in Nigeria lack faith and confidence in the durability of recycled materials. The cost of recycling and a general lack of awareness about reuse and recycling make CDW treatment commercially unviable in the country. The construction industry's multifaceted nature presents challenges as well. Participants believe that collaboration and synergy among the seven building professions in Nigeria are crucial than working in silos.

To improve CDW management in Nigeria participants stressed the need for infrastructure like electricity to support effective waste management practices. They also recommended raising awareness and educating both the public and the construction industry about waste management. One participant even suggested that instilling a sense of patriotism among citizens could contribute to waste management.

Regarding waste picker's role in CDW management, one participant proposed that entrepreneurs interested in waste management should establish businesses focused on supporting these workers. This could involve setting up recycling facilities near areas where waste workers operate, creating a relationship where those workers collect materials for sale to recycling companies. For example, a tricycle company could be located near a waste reuse market, in Aba, Abia State, Nigeria. This approach would promote waste management practices.

The participants also stressed the importance of integrating scavengers into the waste management system, recognizing their role in waste management in Nigeria. To address challenges in managing CDW it was suggested to restructure the construction industry. An alternative approach could involve implementing policies that acknowledge and include waste workers based on the findings from Chapter 4 (Section 4.9). In this section construction participants highlighted the contribution of scavengers to CDW management in Nigeria. Moreover, it was highlighted that godfatherism had an impact by allowing unqualified individuals with no knowledge of waste management to enter the construction industry. This emphasizes the importance of allocating jobs to qualified personnel. Additionally, further research has shown that scavenging can be a lucrative occupation when waste workers are organized and supported by policies. Studies conducted by Medina (2011) and Ezechi et al. (2017) challenge the perception that scavenging is a marginal occupation. Medina (2011) provides evidence that the economic impact of scavenging in Nuevo Laredo, Mexico scavenging had an estimated impact of around half a million dollars per month. Similarly, it was found that waste workers near Beijing dump earn three times more than a university professors' salary.

These examples showcase how scavenging activities can have benefits. It is important for authorities to acknowledge and support scavenging, as an industry of perceiving it as a problem that needs to be eradicated.

5.9.3 Financial Factors

The financial aspect of managing CDW in Nigeria primarily revolves around the associated costs. These costs include the expenses related to CDW management itself, cost of recycling in a challenging environment and the lack of incentives to encourage recycling.

Participants expressed their concern regarding the absence of incentives, which was mentioned 11 times in their responses. This highlights their perception of government involvement and interest in CDW management. In this context, participants view the formation of an association for waste workers as a solution. Such an association could encourage the federal government to provide grants that can be utilized for upskilling workers, acquiring tools and equipment and investing in recycling plants among other things. One participant even suggested; *I believe it is the responsibility of construction professionals to take up this challenge to create a room for them in order to accommodate them in society as they play a vital role in society*.

Furthermore, as highlighted in Section 4.8, the Nigerian construction industry is primarily comprised of small and medium scale enterprises and many informal recyclers lack the skills and resources for recycling. Consequently, participants strongly emphasized the need for government intervention in organizing waste workers into associations while also providing them with equipment (PPE) and financial support.

The creation of associations for waste workers was a prominent topic discussed in the interviews mentioned 24 times. These associations are viewed as essential for waste management as they require collaboration and help eliminate the need for middlemen.

Another significant aspect in Nigeria is the prevailing mindset that doesn't recognize waste as a resource due to the abundance of natural resources. This perception hampers the viability of CDW in Nigeria despite the daily waste generation. The recycling industry is mostly comprised of small and medium-scale enterprises. However, some wasted resources could be exported at a higher value. Participants 3CE and 7QS both identify a lack of value attributed to waste and its recycling as a problem. In Participant 7QS's words; *people don't attach any value to waste* *materials. So, there is the need for reorientation and attaching values to waste materials, that is when reuse/recycling will be implemented.*

Both government officials and participants from the construction sector seem unaware of the value of waste and its adverse effects. However Participant 5CE holds a different view, suggesting that people in his state do recognize the value of waste. In his words; *Because everyone around knows the value of that waste and someone out there has a need for that rubble, and you will see them coming to negotiate for it for a giveaway price.*

5.9.4 Technical Factors

Participants identified the lack of recycling technology as a significant barrier to CDW reuse/recycling. They also expressed concerns about material quality and the absence of quality control measures in the Nigerian construction industry. Therefore, improving technical capabilities in waste management was emphasized. This is particularly challenging due to the fragmented nature of the industry, which is mainly comprised of small to medium-sized enterprises. It was suggested that contractors with " large capacity" and the necessary equipment and expertise could support the required development. However, there is no definition or plan for introducing such contractors into Nigeria's CDW and construction industries.

The involvement of professionals in waste management was considered essential. It was recommended that every contractor conducts an Environmental Impact Assessment (EIA) before undertaking projects. Unfortunately, some contractors intentionally neglect this requirement resulting in incomplete documentation and inadequate environmental assessments.

5.10 Key messages derived from interviews.

Key messages derived from interviews include:

- Strong support for establishing an association of waste workers to provide benefits such as protective equipment (PPE) and financial aid. This highlights the recognition of informal waste workers as crucial contributors to current CDW management efforts discussed in Chapter 4. It is widely recognized that individuals often end up taking these roles due to the conditions in Nigeria**.**
- There is an understanding that the current regulation and management of CDW in Nigeria is inadequate, which not only affects potential reuse and recycling but also poses challenges for handling hazardous materials like asbestos. While having regulations is crucial for ensuring a playing field across the country it may also be necessary to enforce local regulations.
- There is an acknowledgement of the lack of incentives that could drive reuse and recycling efforts in the absence of regulations. In the future, it could be beneficial to establish incentives that reward construction workers who contribute to waste reduction and promote reuse/recycling practices. To address the scarcity of recycling technology through improvements in electricity supply infrastructure, appropriate economic incentives should be considered.
- A major change needed is a reorientation of the population regarding resource scarcity and the benefits of using recycled/reused materials. This shift in perception would require implementing quality control measures for recycled/reused materials to ensure consumer confidence and trust in these products. Additionally providing vocational training programs for construction, recycling and waste workers on waste management and

recycling is crucial for maximizing the utilization of quality reused/recycled materials. This highlights the significance of creating an association among waste workers to promote professionalism and transform the prevailing perception about waste workers.

5.11Theory of planned Behavior (TPB)

TPB was used to reanalyze research findings from Chapters 4 & 5 due to the technical inclination of the initial results. The main highlight of TPB in this research is to encourage positive waste minimization culture and positive behavior towards CDW management. The theory provides an important model for identifying hidden factors influencing CDW reuse and recycling behaviors such as subjective norm and perceived control. Theory of planned behavior encourages positive waste behaviors among construction practitioners, government and the public at large.

Findings from result chapters 4 and 5 affirmed that the main cause of most waste in the Nigerian construction sector is starting construction without complete documentation. It is not clear why companies imbibe the behaviour of starting projects without complete documentation given the likelihood of waste arising. This behavioural factor is worth further investigation. Moreover, there is this subjective norm which involves the acceptance that waste is inevitable. As in many industries, a practice which has gone on for long enough is seen as traditional or inevitable. Moreover, findings from chapter 4 and 5 revealed that barriers to CDW reuse/recycling focus on technical and legal issues - availability of recycling facilities, space to store, transport to reclamation sites, distance, not adaptable for all waste streams, extra cost of recycling, and CDW seen as end of pipe treatment. Though the Nigerian recycling sector is seen to be in its infancy stage, more investments could be made as this sector is seen to contribute to the country's GDP. Moreover, cultural differences impact the adoption of technology. Applying this theory reveals nuances specific to Nigerian construction sectors. In Nigeria, cultural norms and infrastructural challenges have influenced the rapid adoption of technology as a solution to CDW problems, addressing issues of accessibility and affordability. The implications of the research findings encourage the development and implementation of recycling schemes and campaigns to encourage construction participants and the general population to be aware of them.

It is important to understand the best approaches to address the issue of CDW, having established the willingness of Nigerian construction companies to tackle it. Under the TPB framework, main driver to CDW reuse and recycling from this research findings is provision of technical education to construction workers in Nigeria (Section 4,5). Workforce knowledge of reuse and recycling can develop positive behaviors towards its implementation. Secondly, behavioral forces such as policy support and incentives were found significant in determining the individual's recycling intention. People's behavior or attitude is critical for implementing a sustainable waste management method.

Further findings in section 5.10.2 revealed that the Nigerian clients (especially when they are rich) prefer everything new rather than employing recycled products. However, as suggested by (Tverskoi *et al.*, 2021), people with high egoistic concerns would particularly consider the "perceived costs" and "perceived benefits" of environmental behavior for themselves personally. When the "perceived benefits" exceed the "perceived costs", they will have an environmentally friendly intention, and vice versa. Findings from chapters 4 and 5 revealed that CDW reuse, and recycling intention is determined by perceived benefits. Further findings from these chapters revealed that effective management of CDW in Nigeria is mainly driven through regulation and ensuring the implementation of policies. This emphasizes the need for laws on environmental protection to be implemented in Nigeria.

Hence, for sustainable waste management in Nigerian construction industries, the industry practitioners require a positive attitude towards innovations like reuse and recycling of CDW.

5.12 Chapter Summary

The discourse on CDW management in Nigeria reveals a mixed perception among participating policy stakeholders. While some acknowledge efforts to reduce CDW, others express skepticism, with a notable portion believing no effective actions are being taken, except the Lagos State's initiatives, where waste management appears more efficient, possibly due to connections between council members and the state government, indicative of localized successes. Meanwhile, Participant 5CE shares experiences from Anambra State, where enforcement measures, including potential arrest, aim to deter illegal waste disposal.

Participants suggested the formation of an agency tasked with monitoring construction companies' waste disposal practices. They also advocate for policy changes to enhance CDW management. This underscores the need for systemic adjustments to tackle the root causes of waste dumping, reflecting a call for broader regulatory frameworks.

Advocating for a mindset shift towards waste reuse and sustainability, they highlight the importance of institutions like the NIA, NIQS, NITP, and NIESV in educating construction stakeholders and lobbying for government recognition of sustainable approaches. This aligns with the broader narrative of fostering a culture of environmental consciousness and responsibility within the construction industry, emphasizing collaboration between government, institutions, and the public to drive meaningful change.

Recognizing and acknowledging the importance of waste workers is vital when it comes to tackling the issue of construction and demolition waste, in Nigeria’s construction sector. By acknowledging the valuable contributions of these waste workers and providing them with support and benefits, such as through the establishment of an association, their professionalism can be enhanced, and their role in waste management can be further developed.

Equally important is the need to reorient the general population regarding recycling practices and the importance of sustainable waste management. This can be achieved through educational campaigns, awareness programs, and initiatives that highlight the benefits of recycling and the environmental impact of waste generation. By promoting a shift in public perception and behavior towards recycling, the demand for recycled materials can increase, driving the growth of the recycling industry.

Additionally, the provision of economic incentives can act as a catalyst for promoting recycling and sustainable waste management practices. These incentives can encourage construction companies, workers, and other stakeholders to adopt and prioritize waste reduction, reuse, and recycling methods. Moreover, the enforcement of waste management regulations at the local level is crucial to ensure compliance and prevent illegal dumping. By strengthening enforcement measures and holding individuals and businesses accountable for proper waste management, sustainable waste practices can be achieved.

In conclusion, the recognition and association of informal waste workers, along with the reorientation of the public, economic incentives, and local enforcement of waste management regulations, are key factors in fostering sustainable waste management in Nigeria's construction industry.

CHAPTER SIX: PERCEPTIONS OF INFORMAL WASTE WORKERS/ON THE GROUND – THE LIFE OF INFORMAL WASTE WORKERS

6.1 Chapter Overview

This chapter supports objective 5: Evaluate the role of informal waste workers in the reuse and recycling of CDW in Nigeria.

This chapter employs observation and ethnographic interviewing of informal waste workers by proxy to further increase the understanding of the research topic – perception of key actors on the drivers and barriers to CDW management in Nigeria. The analysis includes original pictures and diagrams to help describe the researcher's findings accompanied by review of literature relevant to the findings. The challenges include those related to covid 19, faced while carrying out the field work and presented before the key findings.

6.2 Introduction

Ethnography describes and interprets a cultural, ethnic or social group in their own environment through observation and interviewing (Plowman, 2017).

As described in Chapter 3 (Section 3.4.3.2), the researcher conducted in-depth ethnographic interview with twelve (12) willing waste workers in Ndi Akpakara (scrap place) market in Aba, a city in Abia state of Nigeria. The interview was carried out online while the observation was carried out by proxy in their business environment. 7 among the 12 were informal waste recyclers, three (3) are waste recycling SME's, one owns a metal recycling company, and one is a waste picker (scavenger). Interview was done in Igbo language (their local dialect as participants were predominantly Igbo people).

6.3 Characterization of Informal Waste Worker Roles

The study of waste reuse and recycling of Aba waste workers is empirical research as it is based on observation, as directly experienced by the researcher of an area where currently there are limited data of informal waste recycling activities. This made ethnography very important in this research.

In this research, the context of informality is seen from the social perspective. Informal waste workers in this context denotes unregulated, non-construction participants who mainly collect, reuse or recycle CDW as a job/business or as a means of livelihood. Included in this group are the scrap dealers, informal recyclers, itinerant waste dealers, middlemen, recycling SME's and waste pickers/scavengers. SMEs are included to represent the interface between the informal and formal. However, in effect, SMEs are also informal as they are not organized by any authority nor regulated by the government. The scavengers sort the waste collected so that the finer the segregation, the more value is added. The hierarchy of these roles is illustrated in Figure 6.1.

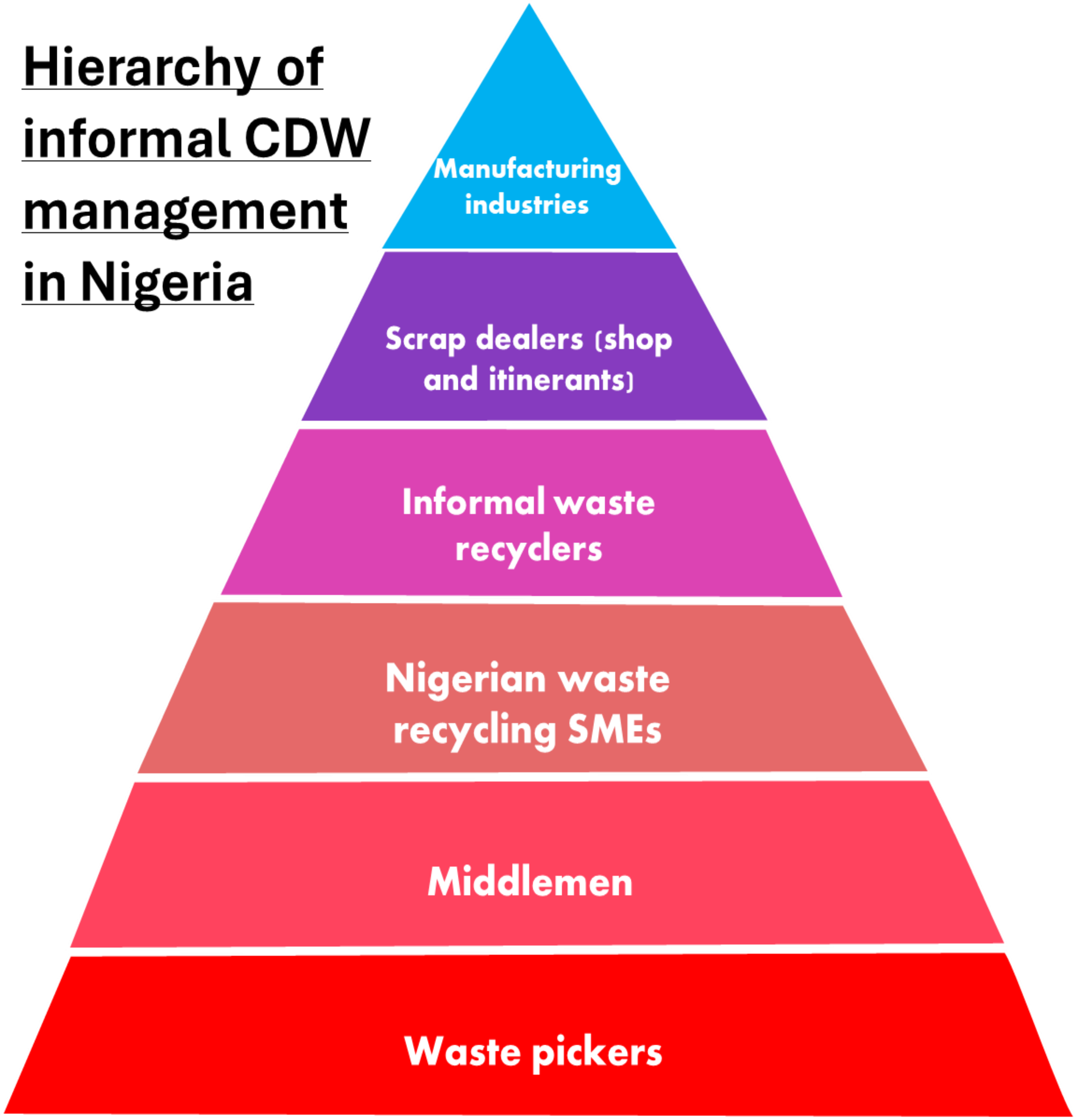

Figure 6.1: Hierarchy of informal CDW management.

The informal waste workers are described in hierarchal order of waste handling below:

Manufacturing industries: The manufacturing companies are formal recycling companies who would rather purchase waste materials from informal waste workers to manufacture materials such as rods, pipes, among other valuables. There is a rising demand for waste materials such as copper, aluminum, lithium, zinc, etc. The metal scrap business has been gathering momentum in some popular cities of Nigeria like Lagos, Abuja, Aba and Kano. It has become one of the trending money- making business among Nigerian youths who through this business have become employers of labor.

Scrap dealers: There are two types of scrap dealers; those who buy and sell in their shops and the itinerant scrap dealers.

Scrap dealers- Shops: They have shops situated in strategic places where they specialize in buying and selling metal scraps recovered by the scavengers. They also buy from importers of waste materials and resell to waste recyclers, welders, middlemen, and recycling industries.

Itinerant scrap dealers: The itinerant scrap dealers buy small quantities of waste from households, street shops and construction sites, such as metals, glass, cartons, plastic, paper and other recyclables. They sell to scrap dealers (shop), SMEs (small and medium sized enterprises), and middlemen.

Informal Waste Recyclers: waste recyclers are non-registered individuals or small micro enterprises (who are not formally responsible for providing waste management) that intervene in waste management by reusing construction and demolition waste (to produce materials like chairs, doors, metal gates, e.t.c). Despite not being registered, the Aba waste recyclers do, however, belong to organized unions, details of which are included later in section 6.5. They buy their waste materials from construction and demolition sites, importers of waste materials and scavengers.

Nigerian Waste recycling SMEs: The Nigerian recycling SMEs are independent firms with a formal structure. They are a group of young start-ups who have inspiration in “waste to wealth” ideas and apply technology on waste management. They work with individuals (an entrepreneur who has a contract with the SME), who are registered under them to collect recyclables. These individuals have stations where they collect recyclables from industries. They also contract several scavengers (whom they pay wages) to collect recyclables which they later recycle.

Middlemen: The middlemen act as a link between the waste dealers and the industry. They engage in buying waste materials from scavengers and sell to the recycling industries. They do not have shops unlike scrap dealers. The middlemen determine the prices of waste materials. Industries offer better prices than middlemen but because waste pickers pick in small quantities and because they have no influence on the industries, they are forced to sell to the middlemen. The middlemen take advantage of the scavengers as a result.

Waste pickers: They are the itinerant waste pickers who engage in free collection of all types of waste from the streets, construction sites, dumpsites, landfills, and municipal garbage bins. Most of the waste pickers pick metal waste. Each type of metal waste has a different price depending on the buyer; hence price is the most influential factor when it comes to waste pickers’ preference for which material to recover. They belong to the bottom of the informal waste trade pyramid. Scavengers function in predominantly in post-industrial countries

6.4 Length of time engaged in the recycling business.

Figure. 6.2 represents the Length of time informal waste workers engaged in the business.

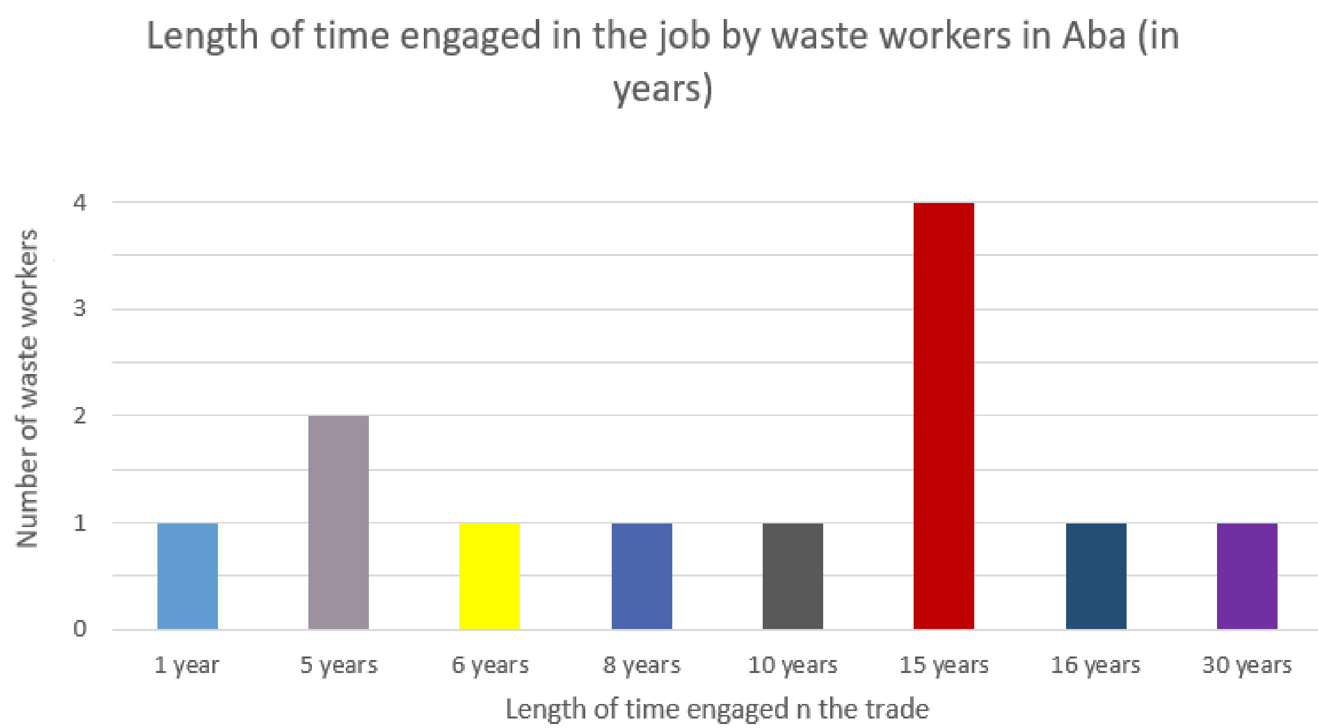

Figure. 6.2: Length of time engaged in the business.

Figure 6.2 reveals that waste work is not a recent occupation in Aba. The figure shows the length of time informal waste workers have been in the role. It was observed that one of the interviewees has been in the business for over thirty years, another has been in the business for 16 years, four have been in the trade for 15 years, one has been in the business for 10 years and five have been in the business for less than ten years. The participant with over 30 years' experience gave an account of how he started as a teenager and continued in the business when he became an adult, got married and had children. Another participant revealed that he educated his six children to graduate level with the money he made from this business and is very proud that they are all doing well financially in their various fields. This denotes that the waste trade is lucrative and has been in existence over a long period of time and waste recyclers have stabilized and made mastery of the business. From Table 6.1, there appears to be progression to higher value materials with longevity. This supports the findings from section 6.3.1 that metal scrap business has been gathering momentum in some Nigerian cities and has become one of the trending money- making business among Nigerian youths.

Table 6.1 shows the length of time informal waste workers spent in the recycling business and the materials they reuse/recycle.

Table 6.1 Number of years in the recycling business

No of years in the recycling business	Role of participants (type of materials reused/recycled)
30 years	Stainless steel waste reuse
16 years	Metal waste recycling
15 years	Metal waste reuse
10 years	Metal waste
8 years	Wood waste
6 years	All types of recyclable waste
5 years	Aluminum waste reuse
1 year	Packaging waste (cement bag)

6.5 Social Participation and Income of Informal Waste Sector

Each waste worker worked an average of 9 hours per day, making sure he achieved his daily target (target set by himself based on value earned). One subject said he wishes to work all the time except when the market closes by 6pm. This denotes that most waste workers work mainly for economic benefits and their daily incomes depend on the amount of time they put into their waste work. (Nzeadibe, Anyadike and Njoku-tony, 2012) noted that it is surprising that waste workers in Aba make a little more than the national minimum wage of Nigeria (the minimum wage is 30,000 Naira, amounting to £54.00). This implies that the informal sector possesses some growth potential and could contribute to realizing the millennium goals of job creation and poverty reduction if given the required policy support (Nzeadibe and Anyadike, 2012).

It was also observed that the informal waste workers have been making meaningful development aids in Aba though the sector is often excluded from conventional urban governance procedure. In Aba, for example, they directly engage with communities and the public where the municipality collects and disposes solid waste as far as they can reach, while the informal sector collects large volumes of waste from inaccessible areas. Hence, informal waste pickers serve these unserved areas with a high degree of efficiency. Hence, efficient delivery of solid waste management and related services can be seen as social participation by the informal sector (Nzeadibe and Ajaero, 2011). This supports the literature findings that informal waste sector thrives to fulfil some social needs in the management of solid waste using skillfulness and entrepreneurship (Nzeadibe and Ajaero, 2011; Wilson, Velis and Rodic, 2013; Mbah and Nzeadibe, 2017a).

When asked of their employment status, nine of them (seven informal recyclers and one scavenger) said that they are self-employed, they own their business though not registered. One participant is a limited liability company registered with the ministry of environment, while three are SME's (small and medium-sized enterprises). There seems to be a more complex picture of informal and formal economy working together. The formal (limited liability company and SMEs work with the informal (scavengers) to manage waste. In the whole Nigerian economy, the Nigerian SMEs contribute to 96% of businesses (Muriithi, 2017). They are businesses with turnover less than N100M per annum and less than 300 employees while the limited liability companies are companies which the liability of its members are limited by shares i.e., the liability of members is limited to the amount they contributed to form and manage the company. In this research, it was interesting to note that Aba waste workers always dressed well, contrary to the reports held by (Gunsilius *et al.*, 2011; Mbah and Nzeadibe, 2017a) that they are always clothed in rags. It was difficult to differentiate them from other people, especially at weekends as they dressed so well when seen in social gatherings.

Waste workers act as the first link in the recycling chain (Ferronato *et al.*, 2018). Issues affecting informal waste management are reflected in the activities of Aba waste workers. Management of waste by Informal actors has not been accepted by the Nigerian policy makers because of the perceived societal prejudices on the informal waste sector. This was supported by policy makers interviewed in 5. 7.1 where they opined that there is no policy for formal reuse of CDW and the implementation of the existing law is lagging. There still exists no official policies or programs in Abia Sate to support this sector, rather the urban governance has been hostile to the operations of this sector. Recent examples are sighted with the prohibition of cart pushers and their activities in Lagos State (Agbesola, 2013). It was observed that the informal waste workers possess socially innovative initiative, yet they were unfortunately not recognized by the ruling authorities, hence not participating in urban governance. They practice social innovations which enables them to their social needs in a better way since government care less of their needs e.g., they form and join unions which protects their working environments, ensures good working conditions, and ensures cleanliness in their environment.

Figure. 6.3 are pictures taken during the field trip. The proxy observer poses for pictures with interviewed waste workers (a) proxy person with metal waste recycler (b) proxy person with wood waste recycler and (c) proxy person with aluminum waste recycler. The waste workers were equally happy to feature in the exercise.

Figure 6.3: Selected waste workers with proxy observer (researcher's proxy field trip, 2021)

The researchers proxy visits to the research territory helped to form deeper knowledge of the informal reuse system. This is one of the advantages of participant observation because it allows the observer to describe deeply and helps to understand the behavior of the observed. Global Report of Human Settlements (UN-HABITAT) argues that informality is extensively growing on a global scale in many countries (Nzeadibe, Anyadike and Njoku-tony, 2012). The report further states that there is a growing acceptance of ‘the informal city’ since urban economy is dependent on informal economic activities which sustains many urban masses, especially when governments is not able provide safety nets to support most people below the poverty level. Moreover, an estimated 60% of urban jobs come from the informal economy and in the next decade, more than 90% of all new jobs will come from the informal sector (Nzeadibe, Anyadike and Njoku-tony, 2012). The case of the Aba waste workers is nothing different from the above. Thus, realizing that informality tends to represent a new mode of urbanism and considering that the urban majority is now inclining to be more informal than formal, there is the need for the inclusion of the informal sector from the urban planning governance (Aboagye, 2018).

The Aba waste workers were proud of their jobs and were very willing to be photographed because they believed partaking in research is a kind of advertisement that will bring them more jobs. The proxy ethnographer interviewed them in their shops and observed that the daily trade begins as early as 8am so he arrives earlier to get hold of whom to interview. It was also observed that they are always in a haste to start work as soon as they arrive. They work all through the day with a break, only when they want to eat (the food vendors move around their business environment daily to deliver food according to demand). The interviews were designed to last for 30 minutes to reduce disruption of their business and livelihood pursuit.

When the informal waste workers were asked if they liked their job and the reason for choosing the recycling job, ten out of the twelve subjects wholeheartedly agreed to loving their job while the other two chose it because of hardship and because there was nothing else to do. Even when some of them joined the business not knowing their future in the business, they were happy they took the bold step. The following are proclamations from by subjects: 2 - *After two years of* *learning the trade, surprisingly, I realized that there is much income therein than my previous trade, I therefore decided to settle for the business. Within three (3) years of working independently I saw a difference/improvement in my standard of living, this made me enjoy my job and settle for it.* 3- *I've always loved this business/trade ever since I started it. I grew up in this environment and learnt this trade after primary school, I get more business proposals with this trade.* 4 - *I can't do anything order than this trade. I left my previous job for this recycling job and I'm happy I made that decision. I'm happy doing it, I earn a better living through it.* The above accounts are not far from those of the rest of the participants. This opposes the school of thought that waste workers are the poorest and the most vulnerable (Medina, 2011), ((Gunsilius *et al.*, 2011; Nzeadibe, Anyadike and Njoku-tony, 2012). This is probably because these authors generalize all the waste workers, but the researcher observed that the scavenger is the most vulnerable. The above accounts also indicates that waste working in Aba may be quite different from that of other parts of Africa. This is probably because they have more business acumen and are more organized than the others. Moreover, Aba, being a business city and being known for its craftmanship, the people must have applied their crafty skills to reuse and recycle construction waste.

6.6 Type of CDW materials recovered and methods of recovery.

Various methods were observed being used for the recovery and reuse of materials by the informal waste workers in Aba. This includes recovery from construction and demolition sites, buying from waste dealers (including buying from imported scrap dealers) and buying from scavengers. Scavengers reported one method of metal recovery which was setting fire to dumps. The fire burns combustibles leaving the metals and scraps. This method, though it helps to reduce the volume of other waste, is harmful to the environment and has safety concerns to the scavengers and people nearby if not controlled. This is because society generally sees waste as an aesthetic problem, while informal waste workers see it as a source of income. Moreover, their activities are seen as unhygienic due to lack of procedure and regulation.

6.7 Percentage of waste workers who search for material types.

Figure 6.3 shows the percentage of waste workers who search for material types. The materials range from metal waste, wooden waste, cartons, plastic, etc. 25% of the participants sort and reuse all types of metal waste, another 25% sort all types of recyclables including metals, 17% sort and reuse only aluminum waste, 17% sort and reuse only wood waste, 8% sort and reuse only stainless-steel waste while another 8% sort and reuse only waste cement bags. From these figures, it can be deduced that most waste workers reuse metal waste. This can be because the value of metal products seems to be higher than other products.

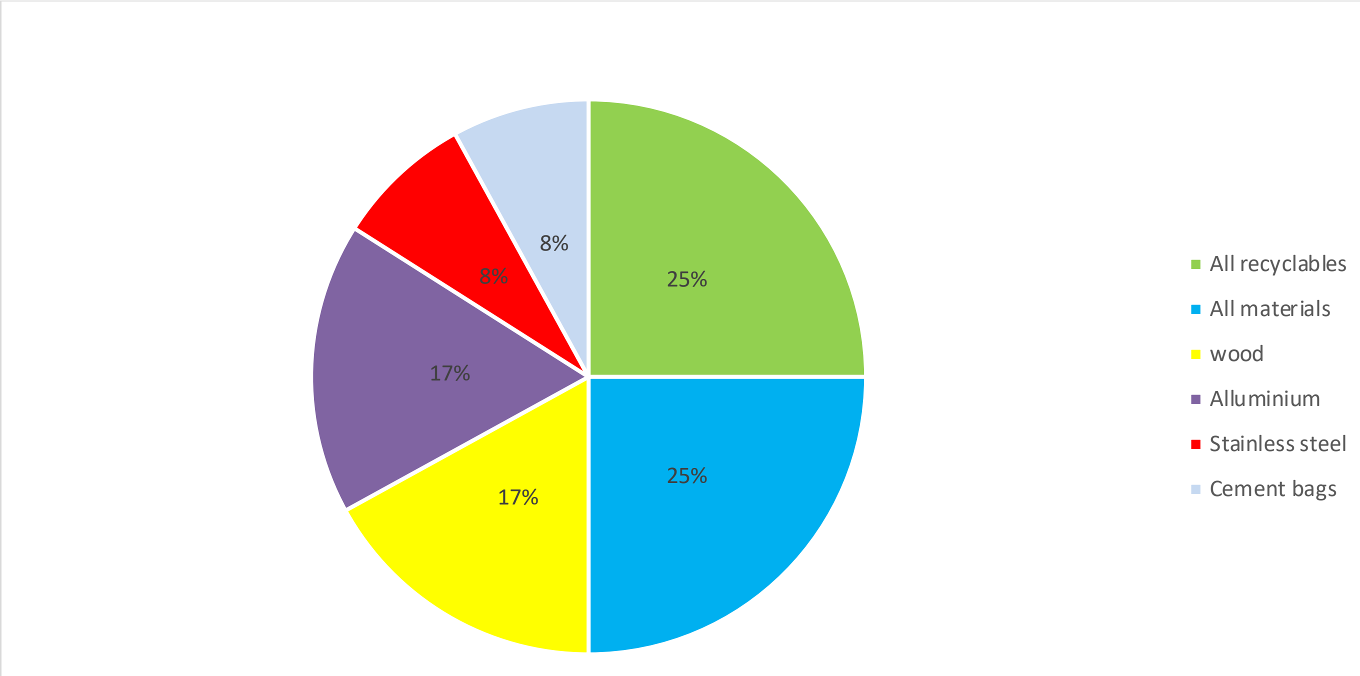

Figure 6.4: CDW material types collected and sorted by participants.

Detailed accounts of the sourced waste materials and their end products are given below:

Subject #1&2 (informal waste recyclers) source their materials from construction sites, aluminum companies and from scavengers. They also buy demolition waste imported from abroad (there are importers who supply them with such waste materials). They also buy waste materials from Ehere market, Urata market and Nkwo Ngwa market (these markets are all located in Aba). These specific participants focus on Aluminum waste of different gauges (3.5mm, 4.5mm, 47mm, 48mm). Not only do they collect the waste, but they also create new products from it. Their products are used nationwide by bakeries. They also produce metal gates and security spikes for fences. When asked why Aluminum was preferred to other materials, they explained it was because of its durability and resistance to water & temperature is far better than other materials. After initial contact by phone, he travels to meet the buyer in person to negotiate prices depending on the type and specification of material. The product is supplied after an agreement is made. When asked if he thinks informal approach results in optimum reuse/recycling of CDW or is there waste which is neglected as it has less/no value? In his response, *I believe it is best to merge the two; government to oversee the business while we, the waste workers, work for the government. Whatever we produce will belong to the government while the government in return will pay us wages and pensions. I believe this is how it's done in other countries*.

Figure 6.4 are pictures of Aluminum waste material (a), Aluminum waste being reused by a waste worker(b) for making baking pans (c).

Figure.6.5 Aluminum waste being worked on to create baking pans (© Researcher's proxy field work, 2021).

Subject #3 (an informal waste recycler) basically deals with all types of metal waste. e.g., rods, pan, etc. He specializes in cutting e.g., cutting of machine parts (he termed it reproduction of an image), hence is called a Porter or Burner. His main clients are welders who produce products from the components. He clarifies the meaning of images by indicating that clients make a sketch of what is needed, and he measures and cuts the metal. He thereafter welds it. Typical products crafted by the burner are iron doors, iron gates and industrial machines such as block molders, molding machines, milling machines for palm oil and melon.

Figure 6.5 are images of products from metal waste reuse by subject #3. Picture (a) shows metal cutting to match images, (b) giant firewood cooking stove, (c) part of a palm fruit milling machine.

Figure 6.6: Iron waste reuse (© Researcher's proxy field work,2021).

Subject #4 (an informal waste recycler), reuses iron waste mainly sourced from demolished buildings. He buys from scrap dealers, waste pickers and offcuts from metal manufacturing companies. Some of his waste materials are imported from China. He went on to explain that the waste pickers/scavengers sell their waste to metal manufacturing companies who recycle the metal waste to produce reinforcement rods, plates/blades and pans (panels), which he thereafter purchases the recycled products from the metal manufacturing companies for use. Primarily, he buys metal waste to manufacture iron gates, iron doors, iron chairs, etc. He prefers to use the waste materials as he aims to achieve a high standard with his products. He sorts the quality suitable for the products he wants to produce. It all depends on the customer's order. He also sells waste metal to welders.

The images in figure 6.6 were taken from subject #3's workshop during the proxy field trip. They are pictures Iron waste and products made from them. 6.6 (a) recovered metal waste 6.6 (b) Iron chairs made with used iron pipes and plates 6.6 (c) recovered and sorted metal waste ready for reuse.

Figure 6.7 Metal waste reuse (researcher's proxy field work, 2021).

Subject #5 (a waste recycler) reuses metal waste. He buys metal waste from construction sites, from waste pickers and imported waste materials (which they normally refer to as Belgium waste probably because they mostly buy from Belgium). He also buys old/unused metals from companies who sell off their old building materials. He reuses them for security gates, assorted iron doors, cooking stove (charcoal stove), traps for bush animals, chairs, tables etc.

He prefers used materials because they are stronger than the new ones and his customers prefer used materials. After production, he polishes and paints these products so that they look exactly like foreign ones. According to him, *you will never know the difference when you see it, rather, you will prefer the old ones.* Figure 6.8 are pictures of metal waste reuse by subject #5. Picture (a) shows the waste worker cutting the metal waste (b) shows charcoal stove on display (c) giant metal gate.

Figure 6.8: Metal waste reuse (© researcher's proxy field work, 2021).

Subject #6 (an informal waste recycler) buys mainly stainless material from importers of metal waste. He explained that he sorts stainless steel waste because of its resistance to rust and contamination. He fabricates industrial (pharmaceutical and food production) equipment with stainless-steel waste materials. Anything that has to do with industrial equipment is what he fabricates. In his words, *when we buy stainless materials, we have different bending materials and welders. I do make the drawings myself and when the drawings are out, the workers will commence work. They will resume production of equipment according to the needs of the customers. My customers come from all parts of the federation*. Some of the Nigerian companies he has worked for includes Eastern distilleries Nigeria limited, Emos best Nigeria limited, Mes Macon international Ltd, Vani wellness, IG chemicals Nigeria Ltd, Castill Industries Nigeria Ltd, De great chuscos enterprises, Rico pharmaceutical limited, Chigin industries ltd, Cleso west African limited. He has also worked for private individuals too.

Figure 6.9 are pictures taken during the proxy field trip – pictures of equipment fabricated from stainless waste. 6.9 (a) pharmaceutical liquid mixer 6.9 (b) is a powder mixer, 6.9(c) is an automated yoghurt filler,

Figure. 6.9: Stainless steel waste reuse (© researcher's proxy field work, 2021).

Subject #7 (a metal manufacturing industry) buys metal waste from scavengers to produce steel rods. His company believes in sourcing these materials locally, hence they buy from waste pickers. Apart from construction waste, they also collect industrial metal waste, all to produce steel rods.

Subject #8 (an informal waste recycler) deals only in wood waste such as planks, plywood and foreign woods. He sources his materials from construction and demolition sites and from markets notable for the sale of reusable waste (e.g Ehere market in Aba). He disassembles and reforms it. He jackplanes the waste wood and refurbishes it in such a way that it will come alive again and look attractive to the eyes. He thereafter repaints it and applies the final finishes, to produce cupboards, wall hangers, beds, chairs, benches and stools. His customers are schools, offices, households, shops etc. He thinks old wood has undergone resistance to various weather conditions and stages of attack (e.g., insect attack). He also believes that waste wood is more reliable and durable. His customers also believe that old wood benefits from having undergone different stages ranging from weather attack, insect attack, etc., making them stronger than recent wood. Most of the heavy woods used for building construction in the early years are no longer available. This has led to the increase in demand for old timber in the reuse market because they are considered of higher aesthetic features than the lumber we have today. These findings denote that older materials are perceived to be more reliable and durable than recent ones. The authenticity of the older materials is particularly valued as the quality of materials in old houses was high and because there are fake and adulterated materials in the market lately. Moreover, reusing building materials seems to be cheaper for the low-income earners living in the city of Aba and its surroundings. The major problem with recent wood is perceived to be that it doesn’t mature enough before felling. Even though he reuses wood waste, it will be hard to realize it in the finished product because it will look as presentable as foreign goods. Figure 6.10 are pictures of wood waste reuse 6.10(a) wood waste and 6.10(b) wood waste reuse.

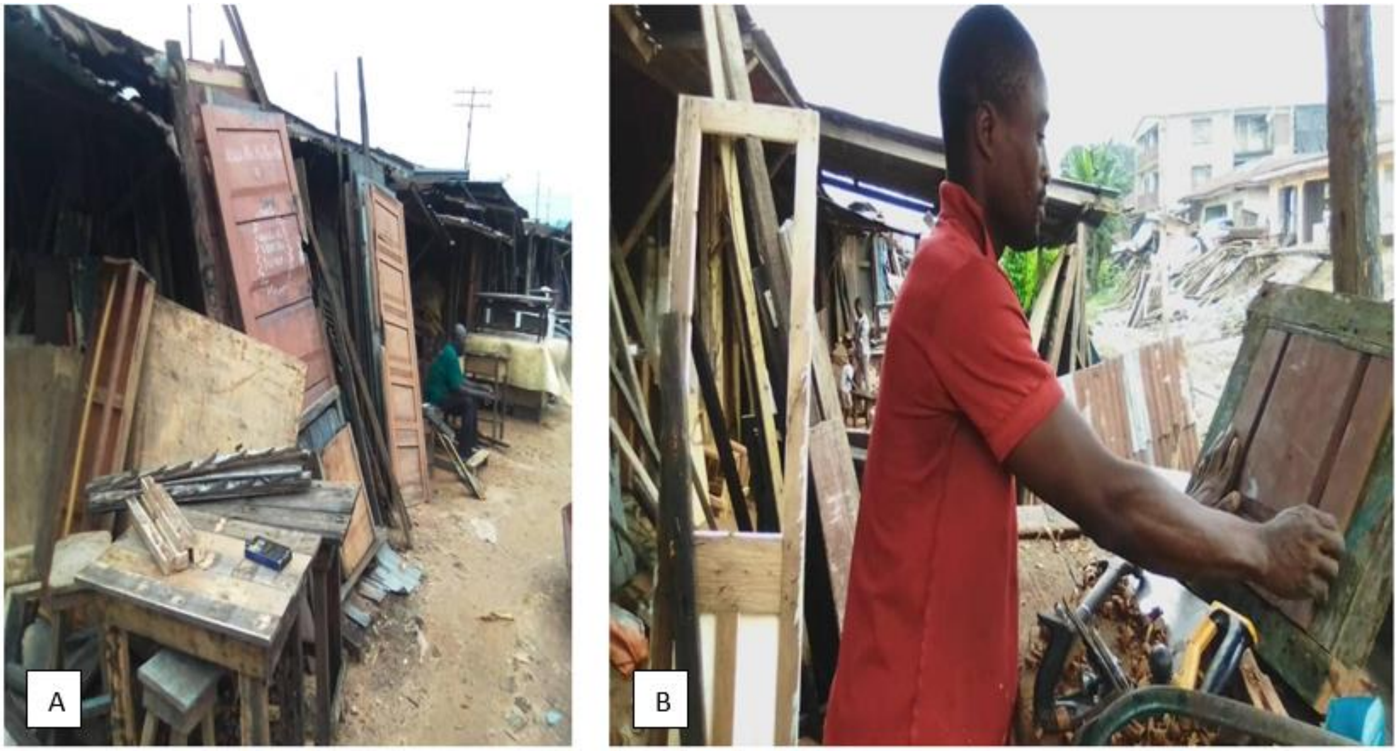

Figure.6.10 pictures of wood waste (© researcher's proxy field work, 2021).

Subject #9 (an informal waste recycler) reuses waste cement bags. She buys waste cement bags from construction sites. She washes them and upcycle them with her sewing machine to make carrier bags, dryer bags to dry cereals (in the northern part of Nigeria, people's main occupation is cereal farming), demarcation/fencing for rural houses, internal walls for poultry houses, ceiling materials (in rural areas), slope protection, etc. In the rural northern areas of Nigeria, people's main occupation is cereal farming. They produce cereals in very large quantities with no access to modern processing systems, so they make use of natural sunlight to dry their goods before storing them in Silos. They need these bags to dry their cereals in their homes or on the tarred road shoulders. They also need thick waterproof bags to spread them. They need these bags to dry their cereals in their homes or on the tarred road shoulders. Some of their customers also use the bags as ceiling sheets for thatched houses, especially in the poor remote areas where poor rural settlers find it hard to purchase roofing materials. Others also use it as demarcation fencing for rural houses or poultry houses. Earth block molders use the bags to cover their blocks during raining season and to cover the blocks to prevent them from dying out too quickly from the sun.

Figure 6.11 is a picture of the waste cement bags being upcycled and reused.

Figure. 6.11 Reuse of waste cement bag (©researcher's proxy field work,2021).

Subject #10 is an employee of an SME recycling company known as Chanja Datti recycling company. This company has recycling hubs located in different centers where recyclable waste is returned and sorted. The company works directly with over 200 male and female scavengers whom they recruit and send to construction sites and households to collects reusable and recyclable waste materials. The scavengers sort their waste when returned to the recycling hubs before their payment is released to them (payment made in relation to amount/value collected). The scavengers specifically collect waste that their company can recycle. e.g., metals, plastics, cartons, rubber, etc. The company recycles cartons to ceiling tiles, they also reproduce parts of upholstery chairs using the waste cartons, and paper egg crates. They produce thick damp-proofing membrane (damp proofing substructure and deck) from the PET bottles and other plastic waste. The plastic bottles are also recycled for GP tanks (to store water in houses and construction sites). They recycle aluminum waste to aluminum roofing sheets. Rubber, electric wires and cables are recycled into new electrical wires, while plumbing materials are recycled to new GP tanks. Some of their metal wastes are exported to China.

They sort the materials locally to help in building the local community. They also employ scavengers because scavengers are specialists when it comes to waste. The SMEs see themselves as formal because they are registered with the government.

They think formal waste management is better because informal waste management does not have enough capital to get it right. In Nigeria, every company is expected to register with the company's registration body known as the cooperate affairs commission (CAC) (Adegbite, 2012). The recycling SME's have the technological and financial ability to recycle waste, hence see themselves as formal waste management systems. They recycle the materials they have the capacity to, while they sell the rest to other recycling companies. They have recycling hubs situated in tough communities in the FCT (federal capital territory, Abuja), where people can take waste from their homes or offices or scavengers can take the materials picked from the environment. They focus on the tough communities to help support them. When people dop off waste from hubs, they are asked to sort their waste but not everyone does the actual waste separation. For this reason, there is a sorter in each hub who does the waste separation so it's easier to recycle when taking back to the company. The SMEs also respond to people calling in who need large amounts of waste dealt with. The SMEs have large trucks to pick up waste which is approximately 500kg or more (just to cover the whole logistics). The hubs have site officers who will access the scale and quality of waste and make payment to the individual. They also collect huge waste materials from companies.

Figure 6.12: Chanja Datti recycling hub (© researcher's proxy field work,2021).

Subject #11 (an environmentalist) who works in the procurement department of a recycling SME company revealed that her company is one of the biggest recycling plants in Abuja. They deal in the recycling of all recyclables their company has capacity to recycle. She opined that Nigerian approach to recycling is powered by harsh economic realities unlike other countries where incentives are given to encourage recycling. Though bodies like environmental health management (EHM) have been in place over a long period. But the attitude/culture of dumping waste here and there is affecting proper functioning of the above body, therefore establishing agencies to educate the masses and small business owners on the importance of waste management. Speaking on policy - there are no specific framework policy on reuse and recycling of CDW in Nigeria. Another way of making CDW effective is enlightenment. If government or relevant bodies organize workshops, seminars, for construction companies, on the effective way to handle this waste. This will also aid in proper handling of CDW.

Subject #12 is a scavenger/waste picker. Scavengers pick all recyclable waste, but the scavenger interviewed opined that he mainly picks metal waste because metal waste has more monetary value than other waste materials. He picks with hooks, magnets, and rods. They thereafter sell to junk shop dealers and middlemen who finally resell to waste recyclers or metal manufacturing industries. Figure 6.13 are images showing; 6.13 (a) a scavenger picking waste material with magnet and rope and 6.13(b) scavengers weighing scraps on a scale.

Figure 6.13 (a) scavenger picking waste with a piece of magnet and rope (b) scavengers weighing scraps on a scale (© researcher's proxy field work,2021).

6.8 Challenges Faced by Waste Workers

Though informal waste workers acknowledge having injuries sometimes, they take it as a normal harm that comes with the business. They don't let this deter them as they believe that profits overshadow the challenges. Other challenges may come in the form of material sourcing, expenses on logistics, foul odor from the waste, contact diseases (contact with waste), mockery (people mock waste workers even the educated ones).

Most of the informal waste recyclers acknowledged not experiencing any form of exploitation. They always have an agreement with their customers, which is binding on both parties. The form of exploitation they may receive might come in the form of short payment. A waste recycler cited an example; *For example, if you give them (the middlemen) 30 tonnes, they will pay you for*

25tonnes instead. When you work for a customer and he doesn't like your handwork he can reject it, so you must refund him. Trans loaders exploit us due to bad roads.

However, Scavengers are sometimes exploited and harassed. Scavengers get exploited by middlemen who they sell to. They also get harassed by the public. According to a scavenger, *the middlemen only give me what they feel like, not the actual worth of my goods.* Though this is mostly found with waste workers, this kind of exploitation can be seen in other aspects of the Nigerian economy.

Most of the waste recyclers acknowledged paying many levies such as infrastructural levy, asphalt fee, power licensing, operational permit etc. This again raises the question of how informal the waste workers are since they must pay fees and levies to organizations such as the local council. The waste workers see this as exploitation since they pay these dues without the government providing the necessary/basic infrastructures like electricity, water, roads, etc. This is unlike what is obtainable in developed countries where citizens pay tax while the government in turn, provides the necessary infrastructures.

When asked if they face any harassment of any sort, five waste recyclers and a scavenger said yes while one SMEs and four waste recyclers said no. This denotes that despite the relevance of their business to their environment, they still suffered harassment. A waste recycler who produces food manufacturing products, cited an example: *The government will not allow us to export anything without NAFDAC (National agency for food and drug administration and control) number and it is very difficult to get this number* NAFDAC was established in 1993 to regulate and control the manufacture, exportation, importation, distribution and advertisement of regulated products in Nigeria (Amadi and Amadi2, 2014). They make sure that Nigerians comply with standards. In Nigeria it is illegal to sell certain products (like food manufacturing products) without NAFDAC number. Another waste recycler opined that the tax force people do harass them as well. Tax force are persons who present themselves as government bodies who sometimes forcefully harass entrepreneurs to pay fees and levies. There should be a better and more formal way of prompting entrepreneurs to pay fees other than harassing them.

Nine of the waste workers acknowledged belonging to a union. The unions are listed in Table 6.1. Non-members were also interested in joining. Belonging to a union provides a kind of protection to the waste workers. The unions are specific to the type of waste material reused. The unions are registered under the local council. Some do not belong to unions as they could not keep up with the union dues, while some declined to response for reasons best known to them. This denotes that the "informal waste workers" is not always entirely informal, as belonging to a registered union entails a kind of formality. It is a requirement to work in certain fields. National association of scrap and waste workers of Nigeria (NASWON), a waste workers union formed in 2018 exists in Lagos State (NASWON, 2021). It is made up of scrap dealers and waste pickers who collect waste from companies, door to door, dumpsites, landfills, slums, and from the street. It was registered in 2021 and has 700 members.

Table 6.2 waste unions and type of materials reused.

Metal and joints association of aba (1 subject)	Metal reuse
Nka na uzu (1 subject)	Metal reuse
Ogun state environmental protection agency (1 subject)	Metal recycling
Recycling association of Nigeria (3 subjects)	All sorts of material recycling
Carpenters and welders' union of aba (1 subject)	Wood reuse
Railway timber and carpenters' association (1 subject)	wood reuse
Association of bag dealers (Jutes and sacks) (1 subject)	Waste bag reuse

Figure.6.14; Waste workers' union members having a session (© Researcher's proxy field work,2021).

6.9 Drivers to Reuse and Recycling Suggested by Informal Waste Workers

The following suggestions regarding drivers to reuse and recycling were from informal waste workers, ranking from most supported idea at top to the less supported idea at the bottom.

Provision of basic amenities: All the informal waste recyclers suggested that the government should repair existing roads and provide constant electricity. This will improve transportation of their waste materials from the production sites to the final consumers. This has earlier been suggested by the interviewed politicians in table 5.2. Moreover, the importance of adequate legislation on construction waste management cannot be overemphasized. Nigeria needs to tackle these concerns.

Provision of mechanical equipment: Four of the informal waste workers also suggested the government provide them with machines to carry out work mechanically. They believed this would help improve the finished products' quality by providing technologies that will add value to finished products before sales. This will also improve their social status and their working conditions.

Positioning of informal waste workers in a permanent site: Four of the informal waste recyclers suggested the government to position all the waste workers in each city to a permanent site. They believe that positioning them together in a permanent site will help to provide better business skills, help to integrate with the public and to secure more quality and quantity of reusable and recyclable materials.

Reduction of cost of reusable materials: Three of the informal waste recyclers pointed out the need for reduction of price of recyclables by local producers of recyclables. The cost of reusable materials has increased due to high demand.

Provision of financial incentives: the informal waste workers opined that government should provide monetary incentives or financial support to the waste workers. This could include providing loans whether they meet the usual credentials to apply for loans or not. A good example of financial incentives is the recent funding agreement signed between the federal ministry of environment, Japanese embassy in Nigeria and the United Nations Industrial Development Organization (UNIDO), for plastic waste management (Wang, 2021). This is to reduce marine plastic waste pollution to a minimum of zero by 2050, across the globe, and especially in Africa, using an inclusive lifecycle approach.

Public sensitization/awareness programs: Two of the three Nigerian waste recycling SMEs suggested the need for regular public sensitization awareness on the importance of recycling. This may come in the form of organizing environmental orientation programs for schools and town hall meetings, sensitizing the public on the importance of taking up a sound solid waste management practice. This can facilitate the implementation of effective and sustainable solid waste management practices in both rural and urban areas.

Provision of gift and food items as an incentive to support recycling: In lieu of this, one of the recycling SME'S pointed out that her company provides gift and food items to primary school children as a form of sensitization in the peri- urban areas of Abuja. This helps in communicating the message in a way and manner they will understand.

Inclusion of waste management into the school curriculum: The three recycling SMEs suggested that the government include waste management into the school curriculum starting from primary up to tertiary education. This is believed to help to inculcate waste management practices in individuals early on time.

Government recognition and regulation of waste workers: A waste picker suggested that the government should include them in her agenda by recognizing and regulating them. Waste pickers play an important role in material recovery, transportation, reuse, and recycling in Nigeria. Hence, they are involved in environmentally friendly activities. This in turn suggests that less time and money will be spent by waste by both formal and informal sector in waste collection and transportation (Wilson, Velis and Rodic, 2013; Marzouk and Azab, 2014, 2014) They believe that government recognition and inclusion will improve the quality of their life and improve their safety at work.

Public private partnership between government and private companies: One of the informal waste recyclers suggested the need for a public private partnership between government and private companies. Waste workers associations function best when included by municipals (Aparcana, 2017). An example is cited in certain areas in Brazil where municipalities have a formal agreement with waste pickers to become the official providers of recyclables in return, they are paid by government just like a private waste company (Rutkowski and Rutkowski, 2015).

Government should fix prices for goods and services: One of the informal waste recyclers and the scavenger suggested that government should fix prices for goods and services and observe what they do and market their products for them. Apart from fixing prices of goods, government should provide sufficient market for reuse/recycled materials because there are loads of materials to be sold. This is because scavengers rely on middlemen in order to reach the top of the pyramid because recycling companies are located in areas where direct access to them is very difficult (Marello, 2013; Brix-Asala, Hahn and Seuring, 2016). This contradicts an earlier point made by the previous informal recyclers who indicates that costs are high because of demand for recovered materials. This might be because of their different sources of waste materials. Some buy from scrap dealers while others source from construction sites, scavengers, or middlemen.

6.10 Challenges Faced by Researcher

The section describes the challenges faced in pursuing this research.

There were some challenges faced by the researcher and resource person during the field trip. Though there were covid issues, the participants were not particularly worried about this as they refused to wear masks. The proxy person, however, was worried about this, so had his mask on whenever he meets with the participants.

Secondly, there were issues travelling to the location. These issues included roads not navigable by motor vehicles, which was worsened by excessive rain (8mm per day) on most days. Where roads were accessible, they were excessively busy (40minutes to travel 5 miles). This suggests the need to carry out this kind of research during the dry season (November until March). A further complication was curfew due to civil unrest (Biafra agitation). This was introduced every Monday and Wednesday all over the eastern part of Nigeria. This meant no travel was allowed on Mondays and Wednesdays for the study and is still ongoing.

After reaching the location, it was not easy to access the waste reclamation area and observe or speak to the waste workers. Potential participants were afraid of sanctioning by the union if they give certain information. Some were also concerned that giving out information could potentially harm their business. This was because they were concerned about the true nature of the research, while others were in doubt of what the information would be used for despite the provided explanatory information on the research. They believed that certain information when given out will affect the business in a sense that people will know the secrets of the business which will jeopardize their profits in the long run. This mistrust arises from the fact that most of the waste workers do not understand the concept of research or the purpose of research. Some are just not interested due to ignorance.

The language barrier was also a problem (those who could not speak English nor Igbo were not interviewed because of lack of an interpreter). There was a major issue with time. 30 minutes to talk was effectively lost either from their work or rest time. There were stages in access, access to the area then access to people. Once access was gained, the next stage was to build trust and rapport by exchanging greetings, jokes, and pleasantries.

Selecting key informants wisely was a challenge. Their pre-selection was based on their capacity which was assessed by visual observation of their goods, and their willingness to talk when asked to grant interviews.

Some potential participants declined to respond because no immediate financial reward was offered - they believe that information is power, therefore should be rewarded. However, some participants wholeheartedly agreed to providing information and their views reflected the opinion of the rest.

As the interviews were carried out by proxy, issues with poor internet service hindered the flow of communication. The resource person's phone battery was frequently low or off due to lack of local power supply. The resource person was supplied with a power bank and a memory card to ease communication. Embarking on this kind of research in Aba in the future requires preparations in terms of backups for mobility, mobile data and power as Aba is known to have poor road and mobile networks.

6.11 Discussion of Chapter 6 Key Findings

Ethnographic interview and observation by proxy of informal waste workers were employed in this chapter. This helped the researcher to have a direct experience of informal waste reuse/recycling in their business environment. As described in section 6.2, informality denotes that the waste workers are not organized by any authority nor regulated by the government. i.e., they are non-construction participants who mainly collect and reuse CDW as a means of livelihood.

The chapter revealed that informal waste workers act as the first link in the recycling chain in Nigeria as can be seen with the example of Aba waste workers. This system is seen to be dominant in other developing countries where scavengers are in the core of waste management (Wilson, Velis and Cheeseman, 2006; Viljoen *et al.*, 2021). Though they possess socially innovative initiative, they are still not recognized by the law.

Despite the environmental, social, and economic problems associated with waste working, informal waste recyclers in Aba makes an average monthly income of a little more than the national minimum wage of Nigeria. Their income is determined by the amount of time they put into the business; hence they tend to work long hours in a day. Though they sort all types of recyclables, many of them sort metal waste as it is believed that metal waste has more monetary value when sold.

Moreover, results from observation in 6.4 revealed more positive aspects of informal waste working as the majority of the interviewed waste recyclers liked their job. This therefore suggest that waste recycling in Aba may be quite different from that of other parts of Africa unlike literature accounts suggested that they are vulnerable (Nzeadibe, Anyadike and Njoku-tony, 2012; Cruvinel *et al.*, 2019; Gutberlet, 2021).

Observation results in table 6.1 revealed that most of the waste workers have been in the business for less than ten years. One interviewee has been in the business for over thirty years. Another informal waste recycler gave an account of how he started as a teenager, became an adult, married, and had children while in the business. This denotes that the waste trade has been in existence over a long period of time in Aba. The above findings seem to imply that informal sector possesses some growth potential and could have meaningful impact in realizing the millennium goals of job creation and poverty reduction if given the required policy support. The waste recyclers reuse waste materials according to the customer's demand.

Unfortunately, the potential of the existing informal reuse and recycling market and their inputs in socioeconomic development, job creation and environmental conservation remains unnoticed. It was also observed in Section 6.5 that all the informal waste workers have been making meaningful development aids in Aba though the sector is often excluded from conventional urban governance procedure. In Aba, for example, they directly engage with communities and the public where the municipality collects and disposes solid waste as far as they can reach, while the informal sector collects large volumes of waste from inaccessible areas. Hence, scavengers serve these unserved areas with a high degree of efficiency.

Moreover, the results in Section 6.4 revealed that waste management by informal actors has not yet been accepted by the Nigerian policy makers because of the perceived societal prejudices on the informal waste sector. For instance, there still exists no official policies or programs in Abia

Sate to support this sector, rather the urban governance has been hostile to the operations of this sector.

The remaining part of the responses were evaluated across the same four themes as for chapter four and five: social, financial, technical, and political factors. More participant responses relate to social factors than the remaining three themes.

6.11.1 Social Factor

Social factors affect the existence and functioning of informal waste workers more than finance does. Some of the key social challenges they face include mockery by the public (lack of social acceptance), exploitation, material sourcing, foul odor from dump sites (due to contamination of waste), diseases and harassment. This, therefore, calls for reorientation of the masses.

Generally, informal waste workers are not socially accepted in Nigeria, and their job is categorized as low grade. Their activities circulate around material sourcing, material sorting, and waste identification for recycling, and many of these activities are basically manual without a tool nor PPE. Though marginalized, informal waste workers have been making meaningful development goals as they directly engage with the communities and the public and are actively involved in efficient delivery of solid waste management and related services (they reach tough communities where formal waste management cannot reach). They also make a little more than the Nigerian minimum wage.

The key response to the question of barriers to reuse and recycle include lack of vocational training, lack of basic amenities, and no interest in recycling by the public. Apart from vocational education, there is also the need for proper awareness of the public on the benefits of CDW reuse and recycle.

This builds upon the findings in Chapter 5 suggesting introducing a nationwide awareness program about waste management in Nigeria.

6.11.2 Political Factors

The above finding seems to imply that informal sector possesses some growth potentials and also have meaningful influences in realizing the millennium goals of job creation and poverty reduction if given the required policy support. This can be in the form of the national waste management policy including the informal sector which will recognize and involve them.

Hence, informal waste recyclers, in response to the question on the driver to reuse and recycling suggested the need for a formal recognition of their activities (inclusive policy which will lead to recognizing and involving them), provision of monetary incentives to support waste workers and provision of tools and PPE. Other areas they feel require improvement include public sensitization and inclusion of waste management in general education. Recognition of their activities and organization of their activities have been highlighted earlier in chapters 4 (Section 4.6) and 5 (Section 5.3.2)

6.11.3 Financial Factors

The key financial challenges faced by informal waste workers are the high cost of materials, operation of waste facility, local levies and logistic expenses e.g., transport, fuel, etc.

Local levies affect informal recyclers and scrap dealers (shops), who pay a lot of levies at their business premises although there is no evidence that the levies were authorized by government. Logistic expenses relate to transport and fuel or their dependence on the itinerant waste buyers to their logistic requirements.

Transportation to the reclamation site and the distance to the site is another very important barrier to waste recycling. The high cost of materials relates to the prices paid by informal recyclers to scrap dealers (shop and itinerant scrap dealers) who in turn have to pay for transport and fuel.

Operation of waste facilities relates to cost of operating recycling facilities by Nigerian recycling SME's. This includes cost of maintenance of waste trucks used to convey waste from one point to another. Lack of funding for waste recycling programs and initiatives is also a major challenge in Nigeria and this can hinder the growth of the recycling SMEs. The operation of waste facility is expensive. Hence, high operational cost results in low profit and forces some of the SMEs to wind up. Further literature findings revealed that limited access to capital is a major challenge for recycling businesses in Nigeria (Dawodu *et al.*, 2022).

The high cost of transportation culture discourages formal means of collecting waste in Nigeria. This is because most of the roads are dilapidated making it difficult for easy transportation - trucks to go through to the rural areas to collect waste while waste pickers can make it on foot.

6.11.3 Technical Factors

Informal waste workers, sometimes, suffer from work-related injuries. Work-related injury may be due to lack of proper safety kit, as they generally work in unhygienic conditions. Hence, as drivers to reuse/recycling, they suggested government to provide them with machines to carry out work mechanically.

Waste sorting on disposal is a foreign culture to Nigeria – probably due to the waste inevitability culture (Section 4.13& 5.2). In most construction sites, spaces are not provided for waste sorting. Non sorting of waste encourages the activities of scavengers – who pick this waste using their bare hands and crude implements. Also, recycling is not adaptive to all waste streams and in the construction industry.

Figure 6.15 represents the hierarchy of informal waste management roles incorporating challenges faced and drivers for each actor at each layer, as a preliminary roadmap for CDW management.

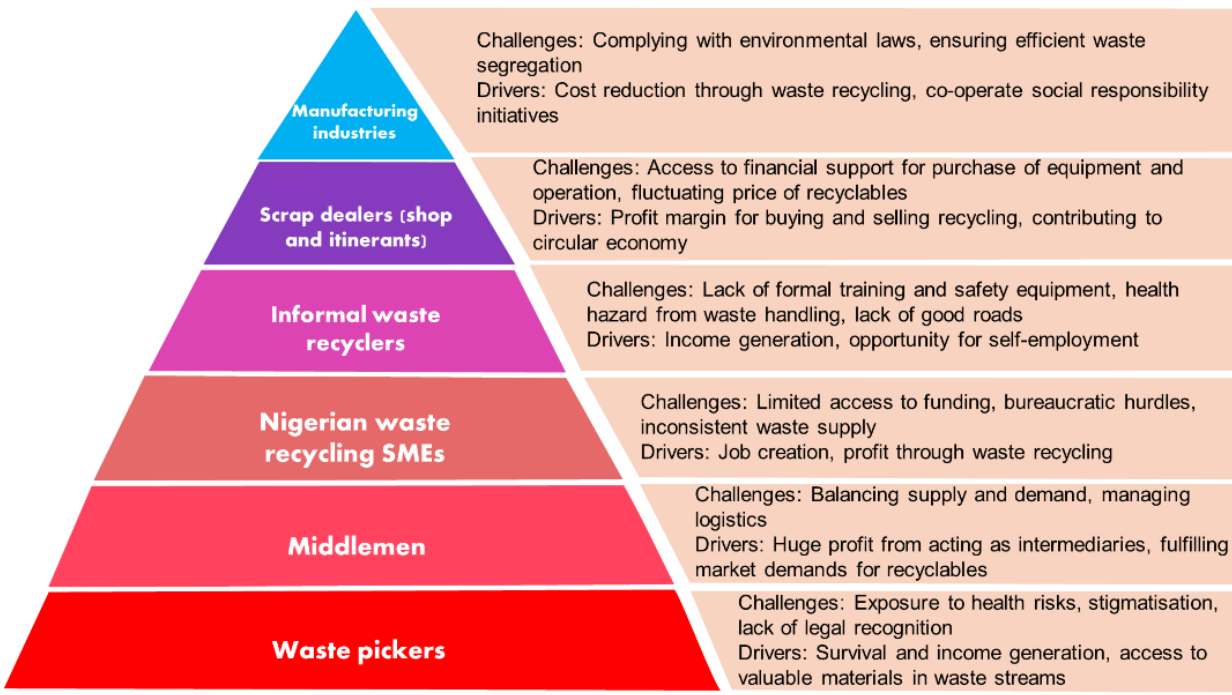

Figure 6.15: Hierarchy of informal waste management roles, incorporating challenges faced and drivers for each actor *as a preliminary roadmap for CDW management*

6.12 Chapter Summary

This section includes the chapter summary showing the perspectives of people at different points within the waste hierarchy.

The informal waste economy, in their hierarchical order includes informal recyclers, scrap dealers, itinerant waste buyers, recycling SMEs, middlemen and scavengers. Though the SMEs are formal per se, there seems to be an interface here between the formal and the informal as the SMEs recruit and work directly with scavengers to carry out waste management business.

A more positive aspect of informal waste working is that most of the interviewed informal waste recyclers liked their job unlike the scavenger who do this work just to make ends meet. The Nigerian recycling SME's have discovered a lot of wealth in waste and see waste management as a viable business. The recycling SME's sort all types of waste while the informal waste recyclers sort mainly reusable construction waste. The scavengers, however, sort mainly metal waste as this has more monetary value when sold.

Generally, all the informal waste workers, despite their level in the waste hierarchy faces mockery by the public. The scavengers especially lack social acceptance, faces diseases and harassment, foul odor from dump sites (due to contamination of waste). The scavengers are exploited by the middlemen and scrap dealers, however, the informal waste recyclers objected to exploitation, but complained about material sourcing.

Key financial challenges faced by informal waste workers are the high cost of materials, operation of waste facility, local levies and logistic expenses e.g., transport, fuel, etc. Local levies affect informal recyclers and scrap dealers (shops), who pay a lot of levies at their business premises.

Logistic expenses relate to transport and fuel or their dependence on the itinerant waste buyers to their logistic requirements. The high cost of materials relates to the prices paid by informal recyclers to scrap dealers (shop and itinerant scrap dealers) who in turn must pay for transport and fuel. Operation of waste facilities relates to cost of operating recycling facilities by Nigerian recycling SME's.

Informal waste recyclers and scavengers, sometimes, suffer from work-related injuries due to lack of proper safety kit, as they generally work in unhygienic conditions. Hence, they suggested the government provide them with machines to carry out work mechanically. All the informal waste workers supported public sensitization and inclusion of waste management in general education as a major driver to reuse and recycling, and this have been highlighted earlier in Section 4.6 and 5.3.2.

The discussion of chapter 6 key findings (which geared towards supporting the recognition of informal waste workers) have produced new answers, which will require a new theory- theory of recognition to better understand the thought directions of the various groups/hierarchy of informal waste workers. Hence, the theory of recognition will help to study more on the interrelationship between these groups and as well integrate similar findings from other chapters (4&5).

CHAPTER SEVEN – NEEDS AND INTER-RELATIONSHIPS

7.1 Introduction

This chapter supports objective 6: to identify the inter-relationships and needs of the informal sector, as a basis for generating a roadmap for the recognition of the informal sector in the re-use and recycling of CDW in Nigeria

Chapter 6 provides the exploration of the role of informal waste workers in reuse and recycling of CDW in Nigeria through proxy ethnography. This included a detailed proxy observation of 12 willing waste workers in their business environment. Initial analysis (Section 6.11) focused on the key themes of social factors, technical factors, and financial factors. From this analysis, social issues were found to be more of interest and worth further study compared to financial/ technical factors because the social factors affect the existence and functioning of informal waste workers (who pioneers waste management), more than finance/technical does. This is also because informal waste workers are generally not socially accepted in Nigeria, and their job is categorized as low grade characterized with manual labor. Hence, their “recognition” warranted further analysis. Moreover, different groups within the informal waste management hierarchy are thinking differently and as well, face different problems divergently, hence, the need to study the interrelationship between them. Therefore, the theory of Recognition is chosen to serve this purpose.

The idea is to further analyze the social challenges related to recognition faced by informal waste workers. By analyzing the role of informal waste workers in the reuse and recycling of CDW through the lens of recognition theory, this chapter aims to contribute to the understanding of the challenges faced by informal waste workers and the implications of their marginalization for sustainable development.

The Theory of Recognition, developed by Axel Honneth (1995), is based on the idea that recognition is essential for human flourishing and social cohesion. The theory identifies three forms of recognition: love recognition, rights recognition, and solidarity recognition. Each form of recognition is essential for individual well-being and social cohesion, and the absence of recognition can have negative consequences for individuals and society.

Social recognition has been discussed in the last three decades in academic scope and public debates (Pereira and Teixeira, 2012). There are different forms of oppression and inequalities that display themselves in differential treatments and social hierarchy, social exclusion and dividing lines including class, ability, race, religion, culture, sexual orientation, and gender. The theory of recognition has been used to illuminate a variety of new social movements e.g., struggle for religious and ethnic minorities, people with disabilities, gays and lesbians (this has been labelled as identity politics because they fight for their identity) (Iser, 2019).

In this research, the concept of recognition covers the entire morality of human relationships. For example, equal right should be understood as struggle for recognition, solidarity should be seen as people having common goals which they work together to achieve.

7.2 Addressing physiological/safety needs using Maslow's Hierarchy of needs.

Before diving into the important themes of Recognition theory (love, right, solidarity), there is need for adapting Maslow's hierarchy of needs to the context of informal waste workers in Nigeria, highlighting the significant challenges they face in fulfilling their physiological and safety needs.

Maslow's hierarchy of needs (1943) is a psychological theory that describes human motivation and needs arranged in a hierarchical structure (Numonjonovich, 2022).

At the foundational level of the hierarchy, we find physiological and safety needs.

Physiological Needs: Physiological needs are the most basic needs required for survival, such as food, water, shelter, clothing, and healthcare. Informal waste workers, in Nigeria face challenges when it comes to meeting their needs due to the nature of their work and the absence of support systems. In areas with infrastructure these workers may have limited access to water. Additionally, they often lack healthcare facilities making them susceptible to illnesses and injuries acquired on the job.

Safety is a concern for waste workers as their work environment and living conditions expose them to various risks. Collecting and recycling waste exposes them to materials, sharp objects and unsafe working conditions. The absence of safety measures and protective gear further exacerbates their struggle for safety needs (Balasopoulou et al., 2017).

The nature of their work can also lead to stigmatization for waste workers in Nigeria resulting in a lack of social support. Unstable income and unpredictable job opportunities contribute to instability for both these workers and their families.

Furthermore, the absence of equipment and materials, like gloves and masks increases their vulnerability to health hazards. This not only impacts their productivity but also poses risks to their physical well-being (Akinade et al., 2016; Cerin et al., 2019). Many informal waste workers in Nigeria face exploitation from middlemen or waste contractors who often pay them meagre wages for their physically demanding work. This economic vulnerability limits their ability to meet their physiological needs and poses a barrier to fulfilling their safety needs (Nzeadibe, Anyadike and Njoku-tony, 2012; Cruvinel *et al.*, 2019; Yu, Blaauw and Schenck, 2020). Consequently, their lack of fundamental human rights, limited access to necessities, unsafe working conditions, inadequate housing, social stigma and economic exploitation all contribute to their ongoing challenges. It is crucial to address the safety needs of waste workers in Nigeria in order to improve their overall wellbeing and productivity. Policymakers and organizations can play a role by providing support systems implementing safety measures enhancing working conditions for these workers. Ensuring access to healthcare facilities and safety training programs along with equipment while advocating for better living conditions would aid in meeting their physical and safety requirements thereby improving their quality of life.

7.3 The Identified concepts relevant to this Framework

The concept of love, rights and solidarity have previously been discussed in Section 3.2.5.

Informal waste workers make significant contributions to the reuse and recycling of CDW, which reduces the environmental impact of waste and promotes sustainable construction practices. However, their contributions are often unrecognized and undervalued, leading to their marginalization and exclusion from mainstream society.

As mentioned earlier, the theory of recognition is based on human struggle to live a good life and aims to correct societal deficiencies. The theory of recognition shares the idea that all individuals and social groups should be accepted and included in their differences. Nigerian waste management sector is largely dependent on the informal waste recyclers activities. The current state of their operation could be described as ‘disorganized’, with a need for Government intervention such as to formalize their roles.

Some earlier identified social factor (Sections 5.8 and 6.11) that negatively affects reuse/recycling of CDW in Nigeria includes: non-collaborative cultures, waste inevitability culture and the influence of godfatherism. The influence of godfatherism introduces a nepotistic element into waste management, where job placements are dictated by personal connections rather than expertise or merit. This practice disrupts the establishment of a skilled and dedicated workforce committed to effective waste control.

Many of the informal waste workers lack access to technical education to get the required skills to carry out their work, storage space to store their products, and financial resources to improve their products and services to the required standards.

The recognition theory recognizes social influence and links it to self-esteem. One’s ability is recognized according to the value offered. Waste recycling offers high environmental and financial value especially in this era of green technology. This theory therefore provides a strong ethical conception of social morality to correct the identified social deficiencies (Mosakas, 2021).

The social factors relevant to this discussion are:

- Non collaborative culture
- Technical education: (lack of funding for people to get sufficient education to get better jobs).
- Elimination of godfatherism
- Waste inevitability culture

These factors arose from chapters 4, 5 and 6.

One of the major barriers to effective CDW management in Nigeria is the non-collaborative culture among different stakeholders. The lack of synergy and cooperation between government agencies, private sector entities, and local communities, results in fragmented waste management efforts. This disjointed approach leads to duplication of efforts, inefficient resource allocation, and the failure to implement comprehensive waste management policies.

This cultural aspect intertwines with the lack of funding for technical education, which perpetuates a cycle of inadequate skills and knowledge needed to address waste-related issues. Proper waste management requires skilled professionals equipped with knowledge of advanced technologies and sustainable practices. However, a shortage of funding for technical education prevents individuals from acquiring the necessary expertise to excel in waste management roles. By investing in technical education and vocational training programs, Nigeria can bridge the skills gap in the waste management sector.

A prevailing waste-inevitable mindset further exacerbates the problem. The belief that waste is an inescapable part of life engenders complacency, inhibiting the urgency for waste removal and disposal. To address this issue, there is a need for comprehensive public awareness campaigns that educate citizens about the importance of waste reduction, recycling, and responsible waste disposal practices. Instilling a sense of environmental responsibility and emphasizing the collective impact of individual actions can help shift the cultural mindset and foster a more waste-conscious society.

Together, these factors reflect a broader theme of institutional and cultural challenges that undermine Nigeria's waste management efforts. Tackling this issue necessitates addressing both the structural deficiencies, such as funding for technical education, and the cultural perceptions that perpetuate wasteful practices. A shift towards collaborative, skill-oriented, and merit-based approaches is crucial to break free from the interconnected web of challenges and usher in a more effective waste management paradigm.

The Nigerian construction industry suffers from poor health and safety practice and legislature (Manu, P., Emuze, F., Saurin, T.A. and Hadikusumo, 2019), and many of the informal waste workers have little knowledge of this rules which are prevalent in other countries (Abd'Razack *et al.*, 2017; Islam *et al.*, 2021). One of their great challenges is travelling to their location on existing bad roads, especially during periods of heavy downpour. Many of them were forced into scavenging due to general lack of jobs in Nigeria and only a few initially saw it as a means to raise income (Nyathi, Olowoyo and Oludare, 2018). Due to not being registered as working or being self-employed, they are denied access to health insurance, unemployment insurance, and credit facilities. Society tends to consider them destitute due to the nature of their work, thereby creating a social disorder.

In many suburb communities in Africa, littering the environment creates a social disorder – waste pickers move with sticks looking for metals and irons to pick. The theory recognizes this social disorder as a 'mis development'. Litter in this context could be viewed as object of disorder – being considered as 'out of place' (Yu, Blaauw and Schenck, 2020). There is this belief in most Nigeria communities that citizens' behavior towards litter (picking it up) is relative to class and those who 'pick up waste' as outsiders even though they provide an essential service. The informal waste workers are among the group that pick-up waste, and some of the social challenges (noted through the interviews conducted) they face identified in this study are:

1. Mockery: People mock waste workers, including the educated one among them. This social perception reduces their self-respect and could only be overcome through rights and

solidarity. Scavengers are generally harassed in many Nigerian community in the discharge of their duties. Since their activities are not regulated, people may not trust their identification. This also leads to disrespect.

2. Exploitation: Waste pickers/scavengers are exploited by the middlemen and scrap dealers (though the informal waste recyclers objected to exploitation but complained about material sourcing). Generally, all the informal waste workers, despite their level in the waste hierarchy faces mockery by the public. The scavengers especially lack social acceptance, faces diseases and harassment, foul odor from dump sites (due to contamination of waste). This could be overcome through rights and solidarity. If people can be educated to see that informal waste workers are part of wider aims to improve the sustainability of CDW management, then potentially a sense of solidarity can be formed.
3. Material sourcing: The materials are generally sourced from unhygienic environments not ideal for their health. This may be attributed to weak regulation and therefore leads to disrespect. The fight for recognition is a fight against disrespect, and therefore regulation is critical to respect, and this can only be overcome through rights and solidarity.
4. Foul odor from waste: They live, dine, dress, and eat within a dumpsite, inhaling foul odors from waste and contact disease. This may be attributed to poor education and poverty, as many of them do not have sufficient funds to get good accommodation. This is like number 3 and relates to disrespect.

7.4 Social Recognition of Informal waste workers in the Nigerian context

This is a struggle to resist forms of equal treatment by a powerful elite. The informal waste workers fall among the marginalized set, and therefore struggle to become a legitimate social agent – with full rights and privileges. Sometimes a demeaning label are attributed to them (Gutberlet, 2021), and they are deprived of their rights as stated in Section 7.3).

Plato's inception of an orderly state is still a problem in our contemporary Nigerian society where government provides little or no infrastructure. In the words of Hedley Bull (a professor of international relations): *there is the perennial tension between the forces of order and forces of disorder* (James, 2015). The balance tends to be shifting towards the latter – forces of disorder in the Nigerian context.

This struggle for recognition could only be achieved within a social context of rights and solidarity (Nancy Fraser, 2003; Nzeadibe, Anyadike and Njoku-tony, 2012). The right aspect of recognition - formalizing their roles and regulating their activities - is also vital as it creates the needful environment.

The normative of (rights) is understood in the context of achieving the status of a 'citizen of Nigeria', and the normative of values is a status the community accords an individual. The key question becomes how an informal waste worker would achieve the status of a Nigerian citizen with full rights and privileges.

Based on interviews conducted with informal waste workers, most of the roads they navigate are still inaccessible, and during heavy downpour, their problem is exacerbated. This shows that they are deprived of their rights to basic amenities as Nigerian citizens – as stated in the 199 Nigerian constitution.

The overall state of informal waste working could be described being in a 'state of disorder', and Honneth presents the theory of recognition to re-evaluate the possibility of assessing norms that can overcome the domination and objectification of individuals as means to an end (Thomas O'Brien, 2013; Mark, 2014). The theory also tries to identify the social norms that could help the population perception of waste workers. To improve their operation, one of the interviewed persons suggests a scenario where: *government recognizes their handwork and supports them morally and financially.*

Unfortunately, Nigerian struggle for everything, including services that should automatically be provided by government such as roads, good healthcare, pipe born water etc. When the people do not feel like citizens of a country, this affects their self-esteem, which when absent, results in stigmatization. The feeling of not being recognized by community members or workplace results in solidarity being undermined. Struggle for value could thus be undermined without communal solidarity.

7.5 Informal waste worker's struggle for physiological and safety needs

The hierarchy of informal CDW management in Figure 6.1 illustrates dependence. The scavengers depend on the middlemen to provide storage space for them, and the informal waste recyclers purchase scrapped metals from scrap dealers and middlemen. The middlemen depend on the waste recyclers to purchase their stored waste in bulk. The waste recyclers depend on the scrap dealers and the manufacturing industry. In some cases (e.g., the case of scavengers), the people at the higher hierarchy tend to exploit those under them – creating disunity and lack of trust. Also, in some cases, the customers exploit the informal waste recyclers as highlighted in a statement by one of the interviewed. *When you work for a customer and he doesn't like your handwork he can reject it, so you have to refund him*. The struggle for survival strengthens when all the players (scavengers, middlemen, waste recyclers, scrap dealers, manufacturing industry) realize the need to support each other. Based on theory of recognition, for physiological and safety needs to be achieved there is a need for rights and solidarity.

In Nigeria context, informal waste workers struggle virtually for everything they need. The system does recognize them, and their basic human rights (right to basic amenities like good roads, electricity, water etc., have been denied them. Their primary need is social acceptance as members of a community and not looked upon as outcasts. But then for an effective struggle, the principles of social philosophy of recognition (love, rights, and solidarity) will guide. In most Nigerian community, our non-collaborative culture hinders the spirit of cooperation. Amongst their hierarchy of informal CDW management (Figure 6.1), there is no spirit of cooperation. *For example, if you give them (the middlemen) 30 tonnes, they will pay you for 25tonnes instead.* This is one comment from one of the interviewed informal waste recyclers that highlights exploitation from within their hierarchy. The first step to recovery should be based on the need for support through rights and solidarity. The need for solidarity makes us know that we are interdependent on each other.

Also, since resources are scarce, people tend to link to the godfathers to get more than what they originally deserve. Godfatherism discourages the spirit of true cooperation and is a big Nigerian cancer. The informal and the formal waste workers also struggle against godfatherism – since it prevents them from getting their rights. To the scavengers, the middlemen sometimes act as godfathers - *give me what they feel like, not the actual worth of my goods.*

7.6 Informal waste worker’s Struggle for respect

To attain the state of respect means the informal waste worker can access facilities like health insurance, credit facilities, car loans, and aids from cooperatives. Their status of disrespect becomes their major hindrance. Disrespect is a form of abuse, and it leads to the denial of one's rights and privileges. Many of the rights of informal waste workers (as highlighted earlier) are being denied them. Respect requires that you realize your rights to participate in institutions of civil governance. In the context of Nigeria, there is the need to formalize the activities of informal waste workers and to properly regulate their activities. Many of these waste pickers go to people's homes without a proper means of identification. Many of the SME's they run are not registered by the government. Without proper regulation and education, attaining the status of a 'legal person' may not be possible since many of them do not even know their constitutional rights.

The response of one of the interviewed waste workers on whether informal approach results in optimal waste reuse/recycle resulted in the following response:

I believe it is best to merge the two; the government to oversee the business while we, the waste workers, work for the government. Whatever we produce will belong to the government while the government in return will pay us wages and pensions. I believe this is how it's done in other countries.

For waste workers to have access to facilities like health insurance, credit facilities, car loans, and aid from cooperatives, government needs to play a more central role.

7.7 Informal waste worker's Struggle to be valued.

It is the desire of informal waste recyclers that the community values their contribution. The struggle to be valued or esteemed relates to unique qualities that makes one valuable. The ability of waste recyclers to create new products using offcuts is a unique quality. For them to stand tall above the others means that "they must do better than others"- in the light of Honneth's statement "allowing individuals to find their functional roles in which to excel, not at the expense of others but precisely to the benefit of the whole". Most of their product currently falls short the quality expected for export. In the light of Honneth's view, not every job serves a basis for one's 'sense of superiority'. The 'sense of superiority' should be based on quality delivery of goods and service, and not putting others down.

One of the interviewed waste recyclers described his product thus: *I polish and paints these products so that they look exactly like foreign ones, you will never know the difference when you see it, rather, you will prefer the old ones.* Some informal workers produce to specification and have customers from different parts of the country. Despite not having the needful resources, many of these workers go the extra mile to provide a good quality finish to their products. This could be described as a struggle to be valued. This determination and self-effort of locally recycling products could still increase the self-worth and value of informal waste workers.

7.8 Recognition of informal waste workers towards sustainable CDW management

The current state of waste management in Nigeria is not environmentally sustainable enough (Aboginije, Aigbavboa and Thwala, 2021). Hence, social recognition and support of informal waste workers will go a long way to creating a sustainable scheme. Recognition and support may come in adult education, central to emancipation and social justice. Educated on common safety precautions; legal rights; their basic rights as Nigerian citizens; and their social responsibilities. Their perception needs to be changed, also, people's perception about them needs to change. This social transformation will go a long way to civilize them, and this is only possible through education, proper regulation, formalization of their roles, provision of capital and provision of recycling facilities. Also vital is a true spirit of rights and solidarity. Social recognition means that role should be recognized as noble, and their rightful privileges (fundamental needs such as good roads, electricity, water, etc.) accorded them.

Figure 7.1 is an expansion of the preliminary roadmap developed in Chapter 6, diagrammatically in cooperating interrelationships and the needs of the informal sector.

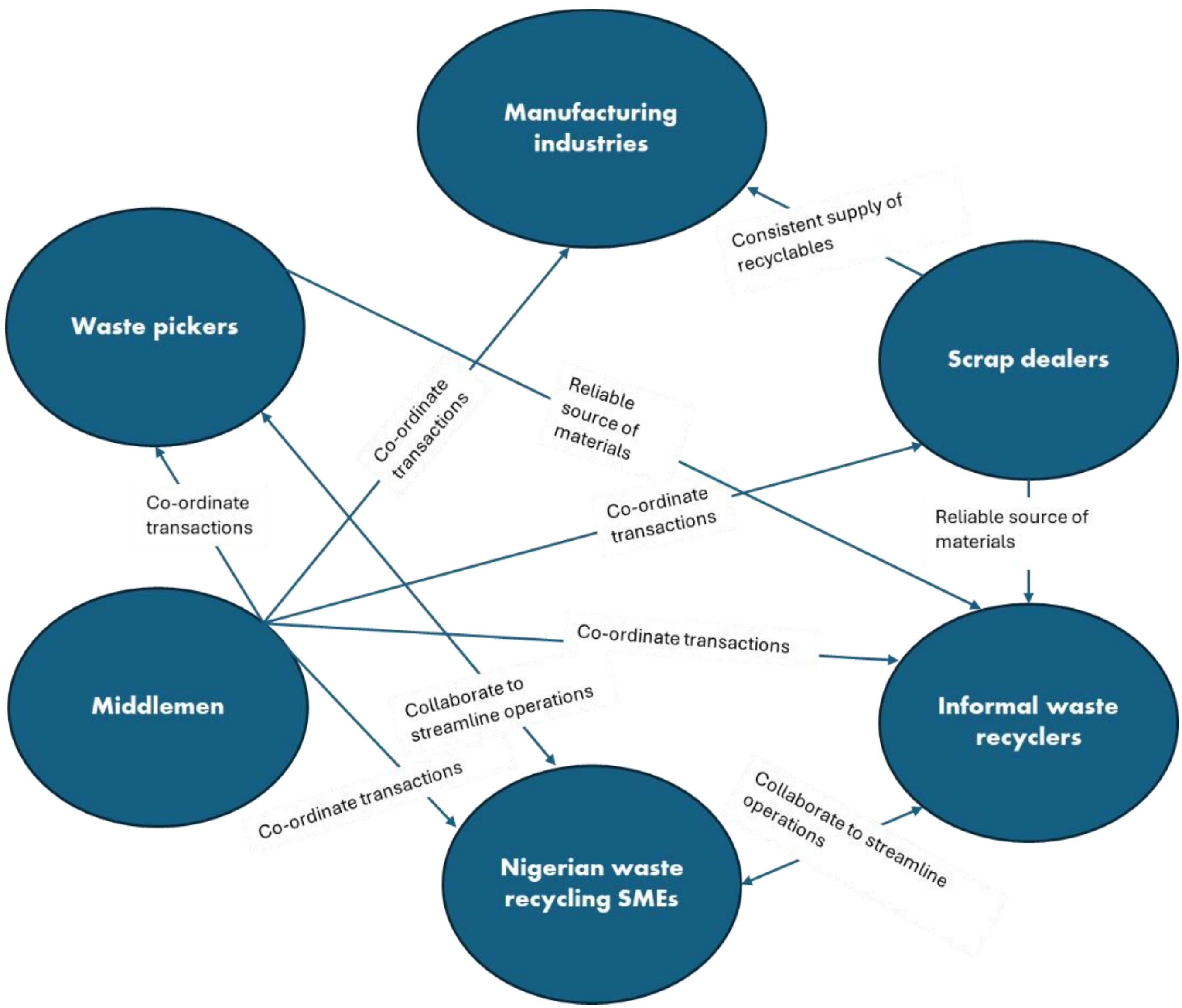

Figure 7.1: A preliminary Roadmap for CDW management in Nigeria: current interrelationships and the needs of the informal sector

7.9 Chapter summary

As stated earlier the concept of recognition was not the initial focus of the study, rather, scope of CDW reuse and recycling and the roles of informal waste workers in facilitating this. Findings from chapter six thematic data analysis were analyzed in relation to the theory of recognition with primary focus on rights and solidarity.

As the Nigerian waste management sector is largely dependent on the informal waste recyclers activities, the theory aims to encourage government recognition of informal waste workers as a key to tackling the current construction and demolition waste problem in the Nigerian construction industry. Recognition will come in the form of support (financial and emotional support), association of informal waste workers, provision of basic needs like roads and electricity and water, etc. Most importantly, the reorientation of the population on recycling and creation and enforcement of waste management regulations will lead to sustainable waste management in Nigeria. Recognition experience will increase contribution towards improved social relations and improved relationships between the government, entire population, and the informal waste workers in Nigeria for sustainable CDW management.

CHAPTER 8 – DISCUSSION

8.1 Introduction

This chapter presents the discussions of key findings emerging from this research. The researcher initially reviewed best practices across the globe (to satisfy objective1), analyze practices that relates to reuse and recycle of CDW in Nigeria (to satisfy objective 2), investigate the barriers to Re-use and Recycling of CDW in Nigeria (to satisfy objective 3), identify the drivers for effective CDW management in Nigeria (to satisfy objective 4), evaluate the role of informal waste workers in the re-use and recycling CDW management in Nigeria, (to satisfy objective 5), and identify the inter-relationships and needs of the informal sector, as a basis for generating a framework/road-map for the recognition of the informal sector in the re-use and recycling of CDW in Nigeria (to satisfy objective 6).

The result findings comprise of the different view expressed by the:

- Construction stakeholders (contractors, architects, civil engineers, quantity surveyors, estate surveyors, project managers).
- Policy stakeholders (politicians who possess professional backgrounds in the construction sector.
- Informal waste workers (Manufacturing industries, Middlemen, Nigerian waste recycling SME, Informal waste recyclers, scrap dealers, and Scavengers).

Their views were obtained to satisfy the research aim and objectives. The key findings were earlier categorized into four different themes – social, political, financial and technical factors. These has now been classified into three broad topics and discussed in

- Section 8.2: The Impacts of Government Policies for Sustainable CDW Management in Nigeria
- Section 8.3: Reuse is a reality: The role of informal waste workers in CDW management in Nigeria.
- Section 8.4: Sustainable waste management: comparing CDW management in developed countries and Nigeria.

8.2 The Impacts of Government Policies for Sustainable CDW Management in Nigeria

This section discussion contributes to objectives 1, 2, 3 and 4.

This research findings revealed that waste management strategies currently applied in Nigeria is mostly landfilling (supported by 53.8% construction stakeholders). This supports the literature studies that CDW mostly ends up in landfills or dumps – an approach which is discouraged in many developed countries (Eze, Onwukeme and Enyoh, 2022; Siddiqua, Hahladakis and Al-Attiya, 2022). Studies on reuse/recycle of CDW in Nigeria is limited (Ayuba *et al.*, 2013; Albert, Shakantu and Ibrahim, 2021). The standard of waste management in Nigeria is still poor and outdated, with poor collection and disposal systems (Aboginije, Aigbavboa and Thwala, 2021; Chisholm *et al.*, 2021).

However, several policy factors were identified by different stakeholders in this study. The policy factors were all intangible (nonphysical, unquantifiable) factors that requires addressing by government, such as;

- Policies covering construction.

- Policies covering education of

    a) wider public

    b) those in the construction industry

    c) informal waste workers

- Policies covering waste management facilities.

Policies covering construction: Most of the construction stakeholders (61%) believed that commencing construction without complete documentation was a significant cause of waste. This can be seen as a policy issue as companies can only commence construction without complete documentation in a system where there is insufficient regulation or policy issues. By law construction firms (during the construction approval process), are required to provide complete documentation as stipulated by Builders Registration Act, 2004 (Elijah Frimpong Boadu, Riza Yosia Sunindijo, Cynthia Changxin Wang, 2019), but they do not, or this documentation in reality, is not checked – this is a policy implementation issue. Complete documentation means that all the documents detailing specific information of activities and phases in a project that the project team should follow e.g., project plan, project schedule, project budget, are made available.

Construction and policy stakeholders identified inadequate regulation and lack of policy implementation as major barrier to reuse/recycling in Nigeria. The fact that incomplete documentation and insufficient regulation to support CDW management ranked highest amongst cause of waste and barrier to reuse/recycle respectively indicates that there are issues with the formal CDW management practice in Nigeria.

Though there are existing waste management laws, most of the policy stakeholders believe that the willingness to implement these laws is lacking. They therefore suggested that the existing laws should be revised to include CDW reuse and recycling and include informal waste workers at both local and national levels. Likewise, literature findings confirmed that the Nigerian government's efforts to implement solid waste management policies have thus far been unsuccessful (Ike et al. 2018). CDW management in Nigeria is reliant on efforts of the informal waste workers (Nzeadibe and Ejike-Alieji, 2020; Hartmann, Hegel and Boampong, 2022). The formal CDW management system is only functional in some parts of some urban cities like Lagos State, due to its technological and political influence.

Moreover, the lack of regulation bodies on site (suggested by 76.8% of construction stakeholders) meant that people didn't feel they had to comply with the regulation. This was attributed to the lack of interest of policymakers in CDW matters.

Policies covering education: Policies on waste reuse and recycling identified in this study that centers on awareness and education include:

1. Limited knowledge of CDW by both government and contractors: Most of the political appointees in charge of waste management in Nigeria have limited knowledge of CDW recycle/reuse and general CDW management. Most of the landfills are not lined and waste sorting prior to disposal is not practiced. The Federal Environmental Protection Agency Act was meant to cover issues pertaining to waste management (Ezeudu and Ezeudu, 2019), however, the guidelines was not detailed on each aspect of solid waste management (such as waste reuse, recycling and disposal). Moreover, the policy did not create room for updating regarding issues that might come up in the future, such as informal waste reuse and recycling.

2. Belief in abundance of natural resources: Policy stakeholders identified "belief in the abundance of natural resources" as a barrier. This was attributed to people's lifestyles that encourage waste and people's desire to have new things and showcase their affluence. Nigeria is blessed with natural resources like crude oil, limestone, tin, copper, timber, etc. (Ezeudu and Ezeudu, 2019). As a result, people do not place much emphasis on waste reuse and recycling. In this study, this attitude was described as waste inevitability culture, and this could be corrected through public enlightenment about the wealth in waste and policy revision to include CDW reuse and recycling.
3. Lack of confidence in the use of recycled material: Most Nigerians also do not have confidence in using recycled products. One of the policy stakeholders described this thus: *people don't really have that faith and confidence that the recycled materials will last a longer time*. This can also be corrected through public enlightenment.
4. Ignorance about the wealth in waste: In Nigeria, no value is attached to demolished infrastructure, and its management is at the discretion of the contractor handling the project. Regarding this, one of the policy stakeholders said this; *there is the need for reorientation of the populace and attaching value to waste materials, that is only when reuse/recycling will be implemented.*
5. Non collaborative culture: The construction industry is resistant to change and most of the construction stakeholders in Nigeria work in Silos. This lack of effective communication and collaboration affects the Nigerian construction industry as it leads to waste, hinders productivity and infringe on construction budgets. Collaboration can be achieved by cross-departmental education and training. The reorganization of the activities of the informal waste workers will ensure that corporative groups (autonomous associations) be created

amongst them for easy access to economic incentives provided by the government. Most of the existing collaborative groups are informal arrangements for collective benefits.

Policies covering waste management facilities: The informal waste workers suggested that government provide them with machines to carry out work mechanically. They believed this would help improve the finished products' quality by providing technologies that will add value to finished products before sales. This will also improve their social status and their working conditions.

The key requirement of informal waste workers centered on recognition by the government/policy. This could be interpreted as a struggle for equal rights – many of the rights of informal waste workers which allow them to participate in institutions of civil governance, are being denied them. The recognition of a worker's right is one of the themes of the theory of recognition. In this research, the concept of recognition covers the entire morality of human relationships. For example, equal right should be understood as struggle for recognition, solidarity should be seen as people having common goals which they work together to achieve. Without proper regulation and education, attaining the status of a 'legal person' may not be possible since many of the waste workers are not properly informed with regards to their constitutional rights. The recognition of one's right is essential for individual well-being and social cohesion but cannot be attained without the realization of their right to participate in an institution of civil governance. In this struggle, equal rights could be understood as a struggle for recognition of one's rights.

Their lack of fundamental human rights - inadequate access to necessities, unsafe working conditions, poor housing, societal stigma, and economic exploitation collectively contribute to their struggle. Addressing the physiological and safety needs of informal waste workers in

Nigeria is crucial to improving their overall well-being and productivity. Policymakers and organizations can play a significant role in providing access to proper healthcare, safety training, protective gear, and advocating for better living conditions can help in meeting their physiological and safety needs, thus enhancing their quality of life.

Informal waste workers struggle for respect - to attain the state of respect means they can access facilities like health insurance, credit facilities, car loans, and aid from cooperatives. Their status of disrespect becomes their major hindrance**.** Disrespect is a form of abuse, and it leads to the denial of once right and privileges.

Informal waste workers struggle to be valued – they struggle for their contributions in the community. The struggle to be valued or esteemed relates to unique qualities that make one valuable. The ability of waste recyclers to create new products using offcuts is a unique quality. One of the interviewed waste recyclers described his product thus: *I polish and paints these products so that they look exactly like foreign ones, you will never know the difference when you see it, rather, you will prefer the old ones.*

Some of the waste recyclers' products currently fall short of the quality expected for export. In the light of Honneth's view, not every job serves a basis for one's 'sense of superiority' (Mark, 2014). The 'sense of superiority' should be based on quality delivery of goods and service, and not putting others down.

Some informal workers produce to specification and have customers from different parts of the country. However, despite not having the needful resources, many of these workers go the extra mile to provide a good quality finish to their products. This could be described as a struggle to be valued. This determination and self-effort of locally recycling products could still increase the self-worth and value of informal waste workers.

Waste pickers (scavengers), for example, go to people's homes, waste collection centers or landfills to collect waste, without a proper means of identification. Also, many of the informal recyclers run a non-registered company. Obtaining their constitutional rights might be impossible without support, regulation, and education. Therefore, government recognition can only be possible through policy reforms.

The stakeholder's opinion on political matters is represented in a Venn diagram in Figure 8.1

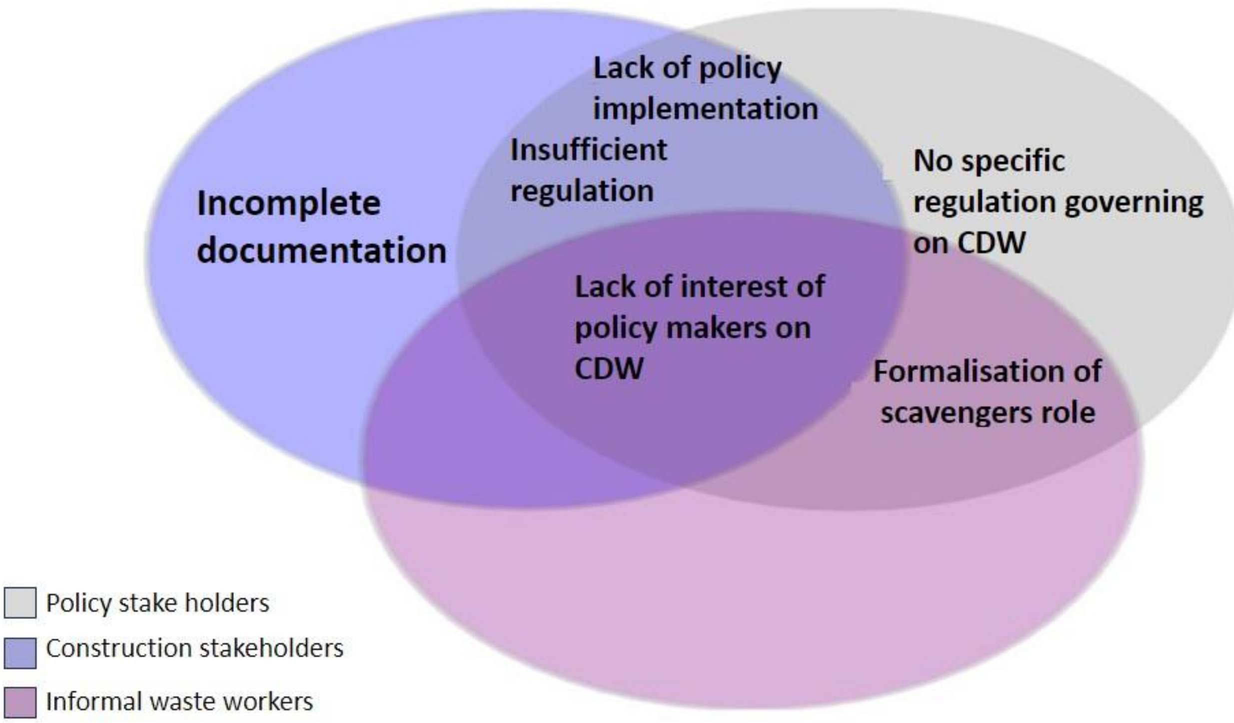

Figure 8.1: Venn diagram showing stakeholders' opinion on government policies for Sustainable CDW management in Nigeria.

The need for political reforms for sustainable CDW management in Nigeria

Both construction and policy stakeholders agreed that there are industrial standards and specifications followed by the Nigerian construction sector, but none covers CDW recycle/reuse. One of such standards is national building legislation of the Federal Republic of Nigeria, published in 2006. This document lacks the power of law as it has not yet been approved by the national assembly (Viljoen *et al.*, 2021). There are also local laws that restrict the dumping of waste, but there is none specific for CDW nor that which encourage reuse of CDW.

Consequently, informal waste workers and private homeowners scramble for these waste materials for their own benefits, without any restrictions or regulations by the rule of law. While education to construction workers was identified as a major driver to reuse/recycling (supported by majority (78.2%) of construction stakeholders). But without a good standard of building regulation, it will be difficult to provide education to construction workers.

Therefore, policy reforms will help to manage waste as waste has environmental effect, some of which include:

1. The environmental impact of non-biodegradable waste - 71.3% of the respondents showed concerns about the impact of plastics and glasses on the environment. They identified the significant impact of non-biodegradable waste.
2. The effect of leachate: 62% of the respondents expressed concern over leachates, as landfilling is the most method of managing waste in Nigeria.
3. The use of virgin materials: Nigerian construction industry also relies abundantly on the use of virgin material. 61.2% of the participants highlighted the loss of natural resources as a major effect.
4. Incineration: Open burning of refuse is a common practice in Nigeria. This is an unacceptable standard in many developed countries.
5. Environmental effect of dust: Dust pollution is common in many Nigerian cities, some of which emanate from construction activities.

8.3 Reuse is a reality: The role of informal waste workers in CDW reuse and recycling and social acceptance, recognition and engagement by policy.

This research has shown that despite the lack of formal CDW management plans and policies, "Reuse is a Reality" through the informal waste workers.

The role of informal waste workers in CDW management in Nigeria was evaluated based on the different views expressed by the three participating groups - construction stakeholders, policy stakeholders and the informal waste workers themselves.

Though literature studies refer to all informal waste workers as scavengers (Medina, 2001; Wilson, Velis and Cheeseman, 2006; Nyathi, Olowoyo and Oludare, 2018), this research findings however, discovered that this is not so, as they are made up of different groups (grouped into a hierarchal order of waste handling from high to low) - manufacturing companies, scrap dealers (shop and itinerant), informal waste recyclers, Nigerian waste recycling SME's, middlemen and scavengers (see Figure 6.1).

8.3.1 Informal waste workers and their struggle for survival

The research findings revealed that both construction and policy stakeholders are of the view that informal waste workers, despite their limited education, play a crucial role in CDW reuse and recycling in Nigeria. However, they are generally not socially accepted in Nigeria and their job is categorized as low grade. Hence, their "recognition" warranted further analysis (this was done using the theory of Recognition).

The Theory of Recognition, developed by Axel Honneth (1995), is based on the idea that recognition is essential for human flourishing and social cohesion. The three themes in Axel Honneth's theory are love, right and solidarity. At the foundational level of right lies physiological and safety needs - this was analyzed using Maslow's hierarchy of needs (1943). Informal waste workers in Nigeria are often denied their basic rights, such as right to freedom from discrimination, the right to fair wages, safe working conditions, and access to healthcare – these are the fundamental human rights of the 1999 constitution of Nigeria (Anazonwu *et al.*, 2022), which should also be their basic right.

The informal waste workers struggle to satisfy their physiological needs of food, water, shelter, clothing, and healthcare makes them economically vulnerable, and their job exposes them to various risks, making safety a critical concern. One of their great challenges is travelling to their location on existing bad roads, especially during periods of heavy downpour. Access to pipe born water is limited for these workers, particularly in areas with poor infrastructure. Access to proper healthcare facilities is also limited, making them vulnerable to illnesses and injuries acquired during their work. Some of the social challenges they face are listed in Section 7.2.

The contemporary Nigerian society is still far away from an orderly state. In the words of Hedley Bull (a professor of international relations): *there is the perennial tension between the forces of order and forces of disorder* (James, 2015). Relating this statement to the Nigerian context, the balance favors the forces of disorder as there exists no good healthcare facility, no good roads, no constant power supply, etc.

8.3.2 The formalization of the roles of Informal waste workers in CDW management

Waste pickers are the lowest in the informal CDW management hierarchy (Figure 6.1). The research findings revealed that the use of waste pickers have proved to be an effective means of reusing and recycling of CDW in Nigeria as both policy and construction stakeholders recognize waste pickers as important to waste management in Nigeria despite their limited education.

Most of the construction stakeholders (52%) agreed that they are aware of waste pickers and believe that they are an efficient solution to CDW management. 52%, being majority of the construction stakeholders also recognize their contribution to material recovery. Likewise, the policy stakeholders also emphasized the importance of waste pickers in CDW management. In support to this, one of the policy stakeholders has this to say; *The Nigerian government have not yet understood the importance of scavengers, most of the environmental laws should be revised to include/integrate the scavengers (waste pickers) into formal CDW management.*

Literature studies also showed that scavengers remove around 30% of waste generated in Nigerian cities (Chimereze, Omokhudu and Ahijo, 2016; Nyathi, Olowoyo and Oludare, 2018). Literature findings also revealed that some municipalities, for example, in Port Harcourt city of Rivers State, Nigeria are planning to integrate scavengers as a lucrative outlet for waste (Amadi and Chijioke, 2018). However, in the hierarchy of informal waste workers (Figure 6.1), there is this anticompetitive market (business practices that prevent competition in a market), does not favour the waste pickers due to exploitative activities of the middlemen.

Hence, significant majority of construction stakeholders suggested that the government should take certain actions to involve waste pickers in the Nigerian waste management system -83.3% suggested provision of technical education, 45.3% suggested formalizing their role.

Interestingly, CDW reuse is effectively practiced in some Nigerian states, despite the lack of effective legislation. One example of such state is Anambra state of Nigeria. Interview participant 3CE opined that one can be arrested for dumping waste in an undesignated place in Anambra State. This denotes that there is a recent wake up call to waste management in Nigeria. In his words; *everyone around the state knew the value of waste and if someone out there deposits rubble, you will see people coming to negotiate for it, for a giveaway price, and so, the idea of dumping CDW* *is not feasible in this area. The basic idea in reuse is that if you don't need it, someone does.* This finding is consistent with (Ogwueleka, 2009), which revealed that approximately 40% of artisans and small-scale industries in Onitsha, the capital of Anambra state, obtain 48% of their raw materials from informal waste collectors.

8.4 Towards Sustainable waste management: Global best CDW management approaches in relation to the Nigerian context.

This section is a comparison of CDW management approach employed in developed countries with that practiced in Nigeria - noting lessons learned from developed countries and how Nigeria can leverage from the advantages from the developed countries. This section supports objectives 1,2, 3 and 4.

Literature studies revealed global CDW management strategies (presented according to their priority in tackling waste). This includes CDW management through reduce, reuse, recycle, treat, and dispose (Oyenuga;hamidiarri;Naoum, 2015; Gálvez-Martos *et al.*, 2018; Huang *et al.*, 2018; Ogunmakinde, Sher and Egbelakin, 2022) .

Reduce: Minimizing CDW from the design and planning stage (designing out waste), has been realized as the best waste reduction approach (Gálvez-Martos *et al.*, 2018). This is because the most significant natural impacts of CDW production are impacted by design choices at the beginning of the development value chain. Waste reduction also involves reducing by as much as possible the amount and impact of materials in the solid waste stream and the impact on the environment of producing it in the first place. The use of prefabricated modules is the most common technique for designing out waste (Silva *et al.*, 2020). (Wu *et al.*, 2016) revealed that source reduction, like adopting cleaner technologies promotes efficiency of resources and aids direct advantage because of their ability to improve profits and lower costs at any point in time.

Circular economy (CE) is another waste reduction strategy that can be employed throughout the development cycle. The central focus of CE is to ensure that waste does not cause harm to the environment and humans. The circularity principle is driven by the overarching issue of sustainable development. In Nigeria, the role of informal waste workers as described in Section 8.3 can be seen as a key component of the circular economy waste management system as they greatly contribute to resource recovery, reuse and recycling. There is evidence of informal waste reuse and recycling operations both in the construction industries and manufacturing industries. Circular economy as a policy has been successfully adopted and implemented in China at various levels (Ezeudu and Ezeudu, 2019). Circular economy has the potential to be incorporated in Nigeria. This research therefore recommends updating the construction and civil engineering policy to include adoption of Circular economy as a policy.

Building Information Modeling (BIM) is a highly technical approach which can contribute to circular economy by supporting tracking of reusable materials at building end of life (Ma, 2018). BIM is not widely used in Nigeria. BIM is a novel approach in developing countries, but is not widely used in Nigeria, hence, would at best be a long-term approach in Nigeria.

Other approaches like prefabrication, and energy recovery, employed both in developed and developing countries, differ in terms of the scale of application.

Reuse. As large amount of energy is consumed in the extraction, manufacture and transporting of construction materials, the ideal arrangement would be for waste arising in one point to be utilized by another, in the equivalent or different businesses, according to circular economy. Hence, waste reuse requires less energy and costs; it releases less pollution, and it preserves the embodied energy originally used to manufacture the item. It also supports achieving zero waste goals (Pagotto and Halog, 2016). Informal waste workers are in the forefront of reuse and recycling in Nigeria. The Nigerian construction industry mostly practice onsite reuse while the onsite reuse method mostly practiced is reuse of excavated soil for landscaping.

Recycling: Recycling involves gathering unused, used, or reused materials which should have been regarded as waste and preparing them to crude materials or manufactured into new items. Countries like Netherlands, Denmark, and Japan have achieved recycling rates above 90% (Carl and Fedor, 2016). Supporting this findings, (Lauritzen, 2018) revealed that some countries have banned the disposal of CDW, except for non-recyclable waste, which is handled by demolition firms.

The recycling rate in Nigeria is less than 12%.(Chimereze, Omokhudu and Ahijo, 2016; Abenu *et al.*, 2022) The inadequate waste collection poses a threat to waste management in Nigeria. Several factors impede the full functioning of the Nigerian recycling sector, including lack of reliable transport infrastructure, insufficient collection method unfit waste disposal method and limited implementation of integrated waste management system. The stake holders suggested that government, through its waste management agencies should establish more recycling plants and waste collection points to boost recycling. They also suggested including environmental education in school’s curricular from primary to higher education level as this will help to sensitize students on the need to reduce, reuse and recycle waste. Both government and citizens have roles to play in raising awareness and pushing the narrative that waste is wealth.

Treat and dispose: The last step is to treat and dispose. Waste is treated to accomplish microbiological changes to create natural organic compounds which can be used for agricultural purposes while materials which are untreatable end up in landfills. While developed countries are exploring the possibility of zero waste, in most Nigerian cities, waste is viewed as valueless, and therefore disposed at random. This research findings revealed that the waste management strategies mostly practiced in the Nigerian construction firms is onsite reuse and landfilling. In Nigeria, no targets are set for recycling and energy recovery. Few of the firms make use of circular economy as a waste management strategy. Literature findings however revealed that Europe has set a recycling target of 70% for non-hazardous waste, and 70% energy recovery (Scarlat, Fahl and Dallemand, 2019).

Literature findings revealed that there are challenges to the implementation global best practices in developing countries because the composition of CDW in developing countries differs to that of developed countries in that developing countries typically produces inert waste like stones, sand, dust, while the developing countries produce noninert waste. This renders it unproductive to employ those management systems used in developed countries.

Moreover, this research findings revealed that what works in other countries might not apply in Nigeria, as Nigeria is different in terms of political system (solid waste management systems however have been crippled due to lack of proper governance and the lack of enforcement of local laws and byelaws as indicated in Section 8.2), hence, the approach might be different. They further argued that until Nigeria experiences political reforms where power control is evenly distributed and the ruling party is accountable for all their actions and inactions, then the effects will be evidenced in the construction sector as well. Nigeria often faces significant challenges in the management of CDW, and as a result, higher proportion of the waste end in landfill, leading to environmental degradation and health hazards (Iqbal et al., 2019). However, Nigerian waste management system is mostly informal. The informal approach entails collecting diverse types of waste from construction sites, households, and informal settlements through informal waste workers. Informal waste workers, as stated in Section 8.2, play a crucial role in diverting waste from landfill sites and facilitating its recycling and reuse.

While literature studies suggested exploring the potential of public-private partnerships (PPPs) as a formal approach for Nigeria and other developing countries (Moruf, Oluwasinaayomi and Mubarak, 2020), this research findings supported the recognition and support of informal waste workers for sustainable waste management.

8.4.1 Technical factors

The major barriers to reuse and recycling of CDW as opined by construction and policy stakeholders is lack of technical education to construction workers, to promote CDW reuse and recycling. This can be supported with literature findings which revealed that the Nigerian construction workforce is heavily dependent on informal knowledge transfer rather than formal training (Ejo-orusa Henry, 2019; Ekekwe, 2021). For example, in Aba, Abia State specifically, most of the technical colleges require rehabilitation, renovation, and rebranding (researcher's opinion). Moreover, CDW is not considered in NIS (Nigerian industrial standards) (Ekekwe, 2021). Construction requires the possession of diverse management talents and skills. Acquiring these skills can only be achieved through experience, while acquiring knowledge necessitates learning in a well-stimulated environment (Salabson, 2019). Although the major causes of waste and waste management strategies can mainly be categorized as technical factors, it is important to consider the potential impact of social, financial, and legal responses as drivers for reuse, recycling, and overall waste management enhancement. These factors introduce additional complexities that warrant further exploration in future research.

8.4.2 Social Factors

Nigeria construction industry is dominated by small to medium sized firms with most of the firms belonging to firms with less than 100 employees. A study examined the cost performance of projects executed by small and medium scale construction firms and observed that small firms specialize in general building works, while the medium firms specialize in civil works (Abosede et al. 2019). Nevertheless, it is evident in this research that most small-scale contracting construction firms in Nigeria comprise small number of employees who may lack the capacity for enhanced employee productivity, digital transformation, and critical knowledge necessary for effective construction waste management within the industry.

Most of the responding construction stakeholders indicated that their firms have a waste management plan. Most of them (74.5%) also showed a high level of awareness and concern about the quantity of CDW produced in their company. Construction stakeholders who have direct experience indicated that masonry is the major wasted CDW material, closely followed by timber/wood products and glass/tiles/ceramics (Figure 4.7).

While policy stakeholders opined that the population are not fully aware of the importance of CDW management, literature findings likewise, revealed low awareness about the environmental impact of indiscriminate disposal of solid waste among the population (Ezeudu and Ezeudu, 2019), this is due to solid waste being a mixture of construction and municipal waste (Tam, Soomro and Evangelista, 2018).

However, despite high awareness amongst the professional, many of them do little or nothing about waste due to the waste inevitability culture prevalent amongst Nigerians. while most of the construction stakeholders believe that reuse/recycling has the potential to effectively manage a substantial amount of CDW in Nigeria.

However, literature findings revealed that embracing new knowledge in construction has been a great difficulty to the Nigerian contractors (Ogunsanya *et al.*, 2022). This is because CDW management policies have not been enforced nor fully understood by the contractors and the wider population (there are no contracts binding the contractor to these). For instance, most of Nigerian populace do not understand what is meant by sustainability nor do they understand the consequence of improper waste disposal (Miner *et al.*, 2020). Though literature findings in Section 2.2.6 revealed that various legislations were enacted during the colonial era to safeguard the environment and the health of the people, solid waste management systems however have been crippled by lack of proper governance and the lack of enforcement of local laws and byelaws as indicated in Section 8.2.

However, this research findings revealed that most of the construction stakeholders indicated their awareness and concern about the amount of CDW their company produces. This implies that potentially they would embrace a change that will lead to more sustainable CDW management. Moreover, most of the construction stakeholder believed that reuse and recycling can manage a substantial amount of CDW, which indicates that reuse and recycling have the potential to be accepted in Nigeria as a method of CDW management. However, the level of willingness will be determined by their understanding of the effect CDW policies.

8.4.3 Financial factors

Interestingly, 92% of the policy stakeholders noted that economic incentives to support reuse/recycling efforts are currently lacking in Nigeria, except for Lagos state, (which provides tax relief for small scale recycling plants, as well as capacity training for people interested in waste collection). An example is found in the University of Lagos, where monetary incentive is provided for the return of plastic bottles (Allen-Taylor, 2022). Such subsidies should also be available for waste pickers to protect them from the exploitation from middlemen. In Nigeria waste pickers sell their products to middlemen, who in turn, sell to manufacturing industries.

Further findings from (NaijalinkLimited, 2021) - revealed that recently, very active waste management authorities in both Lagos and the neighboring Ogun State of Nigeria have emerged. This source further revealed that 70% of the source of finance of recycling companies in Lagos state came from equity financing while the remaining 30% came from financial institutions. Also, corporate bodies and individuals in Nigeria have recently established and promoted avenues for the expansion of recovery of recyclable materials. A typical example is the recycling project in the university of Lagos that provides avenue for monetary incentive for return of plastic bottles (Abila, 2018). Another example is Wecyclers, a company involved in the collection of recyclable materials from low-income parts of Lagos State, Nigeria. They also employ incentive-based method to promote recycling in Nigeria (Abd'Razack *et al.*, 2017). Further literature findings revealed that countries like Mexico, India, and Colombia, scavengers receive as little as 5% of the amount offered by industries for recyclable materials, while middlemen make substantial profit (Asim, Batool and Chaudhry, 2012; Balasopoulou *et al.*, 2017; Steuer *et al.*, 2017).

Findings from this research also revealed that people avoid paying tax. Taxes are required by government to make provision of basic infrastructures possible. As opined by one of the policy stakeholders; *here, people don't pay tax. So, the government cannot function well without taxpayers' money. Everybody should be mandated to pay tax just as is found in the western worlds.* Some developed countries have well-regulated tax collection systems which ensure a level of cashflow is available to provide basic services. This approach would be beneficial in Nigeria to provide services and infrastructure.

8.4.5 Chapter Key Findings

The key findings emerging from this research can equally be categorized into the original themes (social, political, technical and financial factors) as follows.

Political factors: The research revealed several policy issues: Commencing construction without complete documentation was a significant cause of waste. This can be seen as a policy issue as companies can only commence construction without complete documentation in a system where there is insufficient regulation or policy issues. Also, inadequate regulation and lack of policy implementation are major barrier to reuse/recycling in Nigeria. Though there are existing waste management laws, the research findings revealed that the willingness to implement these laws is lacking. This is a policy implementation issue.

Moreover, what works in other countries might not apply in Nigeria, as Nigeria is different in terms of political system, hence, the approach might be different – for example godfatherism is a major political problem, leading to lack of proper governance and the lack of enforcement of local laws and byelaws (as indicated in Section 8.2). They further argued that until Nigeria experiences political reforms where power control is evenly distributed and the ruling party is accountable for all their actions and inactions, then the effects will be evidenced in the construction sector as well.

Social factors: This research revealed that most of the construction stakeholders indicated strong awareness and concern about the amount of CDW their company produces. Strong awareness implies that potentially they would embrace a change that will lead to more sustainable CDW management. Moreover, they believed that reuse and recycling can manage a substantial amount of CDW, which indicates that reuse and recycling have the potential to be accepted in Nigeria as a method of CDW management.

Though literature studies refer to all informal waste workers as scavengers, this research findings however, discovered that this is not so, as they are made up of different groups, grouped into a hierarchal order of waste handling from high to low - manufacturing companies, scrap dealers (shop and itinerant), informal waste recyclers, Nigerian waste recycling SME's, middlemen, and scavengers.

CDW management in Nigeria is reliant on the efforts of the informal waste workers. The informal approach entails collecting diverse types of recyclable waste from construction sites, households, and informal settlements through informal waste workers. This study therefore suggested policy revision to include CDW reuse and recycling and recognition of informal waste workers at both local and national levels, public enlightenment about the wealth in waste. Social recognition means that the role of informal waste workers should be recognized as noble, and their rightful privileges (such as good roads, electricity, water, etc.) accorded them since they greatly contribute to resource recovery and job creation.

Technical factors: Further findings revealed that there are challenges to the implementation global best practices in Nigeria because of the composition of CDW; solid waste in Nigeria is mostly, a mixture of both municipal and construction waste and as well more of organic waste. Developed countries typically produce inert waste like stones, sand, dust. This renders it unproductive to employ those management systems used in developed countries.

There are, however, some informal CDW dumps which are not mixed with municipal waste. One of the points of CDW management is to prevent the waste streams from being mixed to facilitate reuse/recycling. This would also benefit the informal waste workers and should perhaps be an ambition for political change.

Financial factors: Further findings revealed that economic incentives to support reuse/recycling efforts are currently lacking in Nigeria, except for Lagos state, (which provides tax relief for small scale recycling plants, as well as capacity training for people interested in waste collection). Findings also revealed that people avoid paying tax, which helps to provide basic infrastructures. Well-regulated tax collection systems will ensure availability of cashflow to provide basic services. This approach would be beneficial in Nigeria in order to provide services and infrastructure.

8.4.6 Meaning of key findings to the Key stakeholders - informal waste workers.

This research findings reveal that the current state of waste management in Nigeria is not environmentally sustainable enough, but reliant on the efforts of the informal waste workers. However, the efforts of the waste workers have long been unnoticed and unrecognized. This research therefore calls on the federal government and their counterparts at state and local level to reform policies to include recognition of informal waste workers and include CDW reuse and recycling. Social recognition means that their role should be recognized as noble, and their rightful privileges (such as good roads, electricity, water, etc.) accorded them as they greatly contribute to resource recovery and job creation. Recognition and support may come in adult education, central to emancipation and social justice. Educated on common safety precautions; legal rights; their basic rights as Nigerian citizens; and their social responsibilities. Their perception needs to be changed, also, people's perception about them needs to change. Social acceptance of their activity as a viable source of income and of them as environmental agents in the sustainability of virgin resources. This social transformation will go a long way to civilize them. Support may come in the form of financial support to assist in the provision of capital and provision of recycling facilities. Support will also come in the form of providing them with PPEs to safely carry out their work.

Waste workers are often subject to constant harassment and social stigma by the populace and treated as nuisance by the authorities. This study further suggested public enlightenment to change the perception about waste workers and about the wealth in waste. This can come in the form of public events, trainings and workshops.

Figure 8.2 is a word cloud representing the graphical picture based on stakeholders' opinion in chapters 4,5 and 6. This was done to compare the local perception (from the masses and literature studies) against policy stakeholders view (this study). Hence, the bolder the word, the greater the emphasis.

From the word cloud:

- There is strong emphasis on government, waste, and material. Observations from the study show that CDW management is heavily dependent on government role. There is also need for more private companies' participation in CDW management in Nigeria.
- There is greater literature emphasis on recycle than on reuse, but observation from this study shows that a significant volume of waste is reduced through informal waste reuse in Nigeria.
- There is low emphasis on scavengers' role on CDW management in Nigeria, but observation from this study (interview with informal waste workers) shows that waste pickers play a vital role in reuse/recycle of CDW in Nigeria - however, the policy stakeholders fail to recognize their importance.

Comparing local perception and experimental observations in this study shows that local perceptions may not always align with reality (research result). This therefore highlights the relevance of this study.

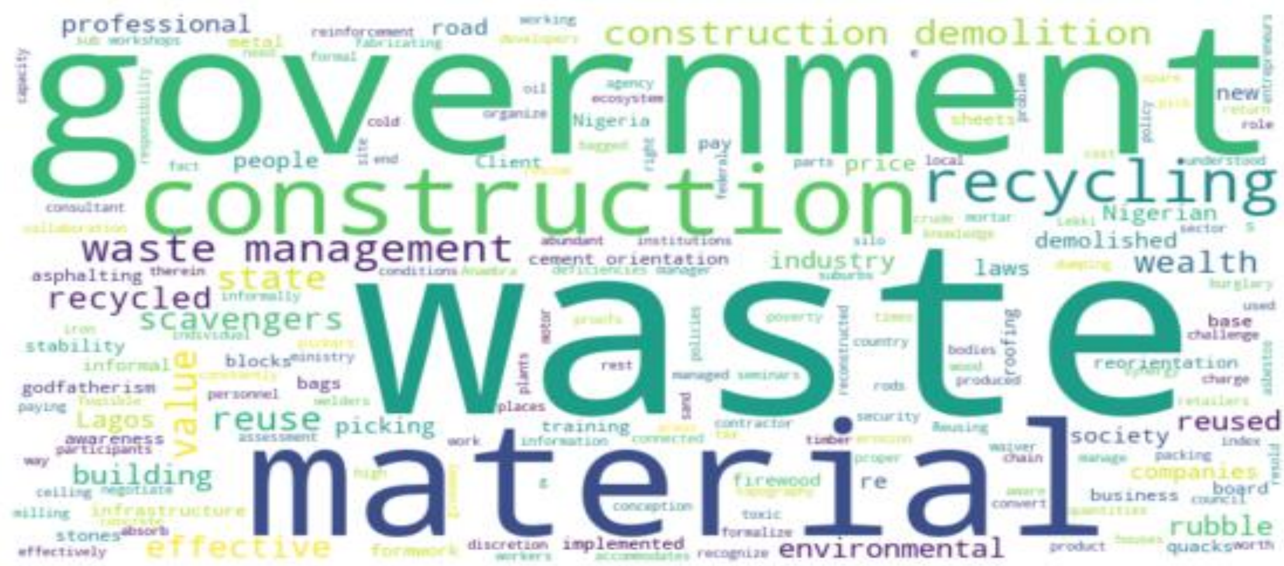

Figure 8.2: Word cloud representing stakeholders' opinion on CDW management in Nigeria

Table 8.1 is a diagrammatic amalgamation of study findings as the final study outcome - A Roadmap for the Recognition of the Informal Sector in the Re-use and Recycling of CDW in Nigeria.

N.b, Stakeholders are those who have a vested interest in the success and impact of waste management initiatives.

Initiator: implies those who conceive or propose the implementation of a project or initiative.

Implementer: are those responsible for executing and managing the practical aspect of a project or initiative.

Table 8.1: A Roadmap for the recognition of the informal sector in the reuse and recycling of CDW in Nigeria

Key actions		Stakeholder	Initiator	Implementer	Time scale
Support and incentives	Organization of transport to different reclamation sites (Fig.4.14)	Government, Construction companies	Construction companies	Construction companies, Government	Short-term
	Provision of waste management facilities (Fig.4.14)	Government, Informal actors, Construction companies	Government	Construction companies	Short-term
	Incentivization (i.e. giving rewards to encourage a specific behavior(Sect. 6.9)	Government, Construction companies, Informal actors	Informal actors	Government	Short-term
	Improved healthcare access and safety measures (Fig.4.21)	Government, Construction companies	Government	Government, Construction companies	Long-term
	Subsidies and financial support for waste pickers(Section 6.9)	Government, Inform actors	Government	Government	Long-term
	Economic incentives for reuse/recycling and waste minimization (Fig.4.18)	Government	Government	Government	Long-term
	Build recycling facilities (Section 6.9)	Government, SME's	Government	Government	Long-term
	Provision of storage space for recyclables (Fig.4.12)	Government, Construction companies, SME's	Government, Construction companies, SME's	Construction companies, Government	Long-term

Key actions		Stakeholder	Initiator	Implementer	Time scale
Documentation and policy	Introduction of selective deconstruction (Fig.4.12)	Construction companies, Government	Government	Construction company	Short term
	Provision of waste skips (Fig.4.14)	Construction companies, Government	Government	Construction company	Short term
	Public-private partnerships (Fig.4.12)	Construction companies, Populace, Government	Construction companies	Construction companies	Medium-term
	Local laws for CDW reuse(Sec.5.8; Sec.6.9))	Government, Construction companies, Populace	Construction companies	Construction companies, Populace	Medium-term
	Government recognition and inclusion of informal waste workers (Fig.4.21)	Government, Informal actors	Informal actors	Government	Long-term
	Complete documentation before construction. (Fig.4.12)	Construction companies, Government	Government	Construction companies	Long-term
	Policy reforms for circular economy and CDW reuse (Fig4.13)	Government	Government	Government	Long-term
	Increased landfill levy (Fig.4.21)	Government	Government	Government	Long-term
	Increased taxation on natural aggregates (Fig.4.12)	Government	Government	Government	Long-term
	Increased dumping/tipping fines (Fig.4.14)	Government	Government	Government	Long-term

Key actions		Stakeholder	Initiator	Implementer	Time scale
Education and training	Safety training and provision of protective gear (Sec.6.9)	Government, Construction companies	Government	Construction company	Short term
	Technological education for waste pickers (Fig.4.21)	Construction companies, Government	Government	Construction company	Medium-term
	Capacity training for construction stakeholders (Fig.4.21)	Construction companies, Government	Construction companies	Construction companies	Medium-term
	Environmental education in schools (Fig.4.14)	Government, Populace, Construction companies	Government, Construction companies	Construction companies, Government	Medium-term
	Awareness programs (awareness about the value of recycled materials) (Sec.6.9)	Government, Construction companies, Populace	Construction companies	Government, Construction companies	Medium-term
	Community engagement (local involvement in recycling initiatives)(Fig.4.21)	Government, SME's, Populace	Government, SME's	Populace	Medium-term
Recognition and inclusion	Policy recognition of informal waste workers(Section 6.9)	Government, Informal actors	Government	Government	Long-term
	Involvement in formal waste management systems(Fig4.14)	Informal actors, Government	Government	Government	Long-term
Sustainable practices	Make specification for recycled materials (Fig4.13)	Government, Construction companies	Construction companies	Construction companies	Long-term
	Long-term environmental benefits (Fig4.14)	Government, Schools, Populace	Populace	Populace	Long-term

Key actions		Stakeholder	Initiator	Implementer	Time scale
Sustainable practices	Digital platforms (Building information modelling) (Fig.4.13)	Government, Construction companies, SME's	Government, Construction companies	Government, Construction companies	Long-term
	Circular economy (Fig.4.13)	Government, Construction companies, Populace	Government, Construction companies	Government, Construction companies	Long-term
	Use of standard material sizes to reduce off cuts (Fig.4.13)	Government, Construction companies	Government, Construction companies	Government, Construction companies	Long-term
	Design for the construction (Fig.4.13)	Construction companies	Construction companies	Construction companies	Long-term
	Prefabrication (Fig.4.13)	Construction companies	Construction companies	Construction companies	Long-term

Key actions	Priority	Short term	Medium term	Long term
Organization of transport to different reclamation sites	High Priority	X		
Provision of waste management facilities	High Priority	X		
Gifts and food items to support recycling efforts	Low Priority	X		
Introduction of selective deconstruction	Medium Priority	X		
Provision of waste skips	Medium Priority	X		
Safety training and provision of protective gear	High Priority	X		
Public-private partnerships	Medium Priority		X	
Local laws for CDW reuse	High Priority		X	
Technological education for waste pickers	High Priority		X	
Capacity training for construction stakeholders	High Priority		X	
Environmental education in schools	Medium Priority		X	
Awareness programs (awareness about the value of recycled materials)	Medium Priority		X	
Community engagement (local involvement in recycling initiatives)	Medium Priority		X	
Improved healthcare access and safety measures	High Priority			X
Subsidies and financial support for waste pickers	Medium Priority			X
Economic incentives for reuse/recycling and waste minimization	High Priority			X
Build recycling facilities	High Priority			X
Provision of storage space for recyclables	Low Priority			X
Government recognition and inclusion of informal waste workers	Medium Priority			X
Complete documentation before construction	Low Priority			X
Policy reforms for circular economy and CDW reuse	High Priority			X
Increased landfill levy	Low Priority			X
Increased taxation on natural aggregates	Low Priority			X
Increased dumping/tipping fines	Low Priority			X
Policy recognition of informal waste workers	Medium Priority			X
Involvement in formal waste management systems	Medium Priority			X
Making specification for reuse/recycling materials	Low Priority			X
Long-term environmental benefits	Low Priority			X
Digital platforms (Building information modelling)	Low Priority			X
Circular economy	Low Priority			X
Use of standard material sizes to reduce off cuts	Low Priority			X
Design for the construction	Low Priority			X
Prefabrication	Low Priority			X

Figure 8.3 Roadmap in Gantt chart form showing key actions against time frame for execution

8.5 Chapter Summary

This research findings revealed that the waste management strategies mostly practiced in the Nigerian construction firms is onsite reuse and landfilling, while the onsite reuse method mostly practiced is reuse of excavated soil for landscaping, majority of the waste materials are disposed in regulated and unregulated landfills. The most wasted material in the Nigerian construction sites is masonry.

Construction stakeholders expressed strong awareness and concern about the amount of CDW produced in their companies. They also believed that reuse and recycling can manage a substantial amount of CDW, which indicates that reuse and recycling have the potential to be accepted in Nigeria as a method of CDW management.

CDW management in Nigeria is reliant on the efforts of the informal waste workers. While CDW reuse supports circular economy, the role of Nigerian informal waste workers can be seen as a key component of the circular economy waste management. This study therefore suggested policy revision to include recognition of informal waste workers. Recognition comes with supporting them through financial incentives and provision of PPEs to safely carry out their work. Recognition will also ensure that corporative groups (autonomous associations) be created amongst informal waste workers for easy access to economic incentives provided by the government. The research also recommends updating the construction and civil engineering policy to include circular economy as a policy.

CHAPTER 9 – CONCLUSION AND RECOMMENDATIONS

9.1 Chapter Overview

This chapter presents the conclusion of the overall thesis. The chapter begins by presenting the aim of the study and objectives used to meet this aim. It continued with a detailed presentation of how each of the objectives were met. The study findings have established the potentials for the Nigerian construction industry to reuse and recycle CDW as a sustainable waste management strategy and established the studies' contribution to knowledge. In addition, the chapter offers recommendations, limitations of the research, and directions for further research and a final reflection.

9.2 Aim and objectives

The main aim of this research was to investigate the role of informal waste workers in reuse and recycling of CDW in Nigeria.

To achieve this aim, six research objectives were investigated and analyzed in chapters 4,5,6 and 7. This was supported with review of related literatures which represents the secondary data and presented in chapter 2. Subsequently, the key findings which emerged from the research were discussed in chapter 8. The research objectives are as follows.

1. Review best practice relating to reuse and recycling of CDW globally in the context of the existing design and construction processes.
2. Analyse current practices relating to reuse and recycling of CDW in Nigeria.
3. Investigate the barriers to reuse and recycling of CDW in Nigeria.
4. Identify the drivers for effective CDW management in Nigeria.

5. To evaluate the role of informal waste workers in the re-use and recycling CDW management in Nigeria,
6. To identify the inter-relationships and needs of the informal sector, as a basis for generating a road-map for the recognition of the informal sector in the re-use and recycling of CDW in Nigeria.

The study was based on realist ontological belief, which establishes that the information held about CDW management in Nigeria as an existing truth, applying both objective and subjective epistemological approaches. The research strategy employed in this study is pragmatism, employing both positivism and interpretivism philosophy and integrating quantitative and qualitative research methods.

The methods adopted in this study are summarized in two phases- phase 1 and phase 2. Phase (1) contains data from construction and policy stakeholders which were more of technical data and was analyzed based on theory of planned behavior by Icek Ajzen (1985). While phase (2) was more of social needs and was examined using the Theory of Recognition by Honneth (1995, 1996, 2004, 2007, 2010), Taylor (1994), and Fraser (2000, 2001, 2003).

9.3 Objectives Met

9.3.1 Objective 1

Review best practice relating to reuse and recycling of construction and demolition waste globally in the context of the existing design and construction processes.

Objective 1 was achieved through a review of related literature and questionnaire survey of construction stakeholders in Nigeria. Data from the literature studies and analysis of the survey provided useful information on global best practices related to reuse and recycle of CDW.

While literature studies revealed that material waste is mostly generated by the construction industry (Ogunmakinde, Sher and Maund, 2019), the impact of this waste includes pollution, climate change, energy consumption and resource depletion (Ogunmakinde, Sher and Maund, 2019).

Global best CDW management strategies were established and presented in this study, according to their priority in tackling waste - CDW management through reduce, reuse, recycle, treat, or dispose. Minimizing CDW from the design and planning stage (designing out waste), has been recognized as the best waste reduction approach while disposal to landfill is considered a last resort. The next best option for CDW is reuse - ensuring waste material is reduced in an efficient manner which is possible through direct or indirect use (Alite *et al.*, 2023). Reuse requires less energy and reduces costs compared to new materials. Environmentally, reuse reduces greenhouse gas emission, reduces waste, and air pollution (Bains, Hongyi and Jialong, 2019; Wang, 2021).

Recycling involves gathering unused, used, or reused materials which could have been regarded as waste and preparing them to be crude materials or manufactured into new items. For example, inert waste (bricks, concrete, soil and stones) can be crushed to make aggregate materials such as concrete or asphalt. Metal waste can be recycled to produce new metal (this uses less energy than producing metal from scratch. Wood waste can be reused for making landscaping pellets, chipboards, garden mulch, animal bedding, or reused as fuel.

Waste is treated to accomplish microbiological changes to create natural organic compounds which can be used for agricultural purposes while materials which are untreatable end up in landfills. Hazardous CDW like electrical wiring and asbestos must be disposed of in a safe and secure manner to prevent risk to human animals and the environment.

In Europe, a recycling target of 70% for non-hazardous waste, and 70% energy recovery is set (DEFRA, 2016; Villoria Sáez and Osmani, 2019). The recovery rate in Europe, when compared with China and the US is quite high, reaching almost 90% in 2020 (Eurostat, 2020).

From these findings, other waste disposal methods aside from reuse and recycling are environmentally unfriendly, therefore, unsustainable. The findings also denote that sustainable CDW management is widespread in some developed countries and underdeveloped in some other countries. Hence, sustainable CDW has become a major challenge for the construction industry. It is therefore necessary to ensure a higher proportion of reuse and recycling in order to improve the overall sustainability of the construction sector.

9.3.2 Objective 2

Analyze current practices relating to reuse and recycling of construction and demolition waste in Nigeria.

Objective 2 was achieved through the discussion of the findings from construction and policy stakeholders as discussed in section 8.2.

The study findings reveal a growing concern over poor standard of CDW management, which results to environmental problems in Nigeria. This supports the literature findings that the amount of CDW generation in Nigeria is undocumented and unknown (Onamade, Asaju and Adetona, 2022), and that material wastage in the Nigerian construction industries exceeds the estimator's allowance. Though participants revealed concern about the amount of CDW, waste, in Nigeria, is viewed as inevitable, hence, disposed at random, and no targets are set for recycling and energy recovery. Hence, the recycling rate in Nigeria is low, while developed countries are exploring the possibility of zero waste. For instance, countries like Netherlands, Denmark, and Japan have achieved recycling rates above 90% (Carl and Fedor, 2016, Lauritzen, 2018). Waste inevitability attitude can be seen as an underlying factor in achieving effective CDW minimization. The findings reveal a high awareness level among construction practitioners, however, their awareness did not translate into action, as evidenced by the high volumes of waste generated.

This research findings revealed that in Nigeria, emphasis is still on use of standard material sizes to reduce offcuts (supported by 65.8% construction stakeholders). With regards to current practices with reuse and recycling, the research findings revealed that on-site reuse is the most practiced reuse method among Nigerian contractors, while the onsite reuse method commonly employed is reuse of excavated soil as backfill.

Waste disposal in regulated and unregulated landfills is still the most common general waste management method in Nigeria. Though this method is the cheapest and most economical waste disposal method, it is short of global standard as it is not only unsatisfactory but unfavorable to human health. This waste management method is environmentally unsustainable because it produces leachates which contaminate the ground water, causing air pollution. (Ogunmakinde, Sher and Maund, 2019). Hence, this method is of major concern due to the high rate of waste generation. Open dumping is also common in Nigeria, where CDW is dumped in open places such as roadsides, site corners, which causes fire hazards, and airborne diseases (Nnaji, 2015; Cruvinel *et al.*, 2019). The study revealed an association between company size and waste management awareness.

However, the study further revealed that CDW reuse is a reality, as CDW reuse and recycling in Nigeria is mainly carried out by informal waste workers who collect, sort, and process the waste materials in a circular economy principle. As one of the policy stakeholders noted that '*our ecosystem is incomplete without the scavengers*.

Therefore, for sustainable waste management in Nigeria, the key point suggested in this research is the need for legislative reform to include reuse/recycle of CDW as currently, there exists no industrial standards and specifications that covers CDW reuse and recycling in Nigeria. Having established in Section 8.4.5 that reuse and recycling of CDW in Nigeria is mostly carried out informally, legislative reforms should also extend to inclusion of informal waste workers who practice circular economy CDW management. One way of recognizing their rights is when their activities are formalized, supported, and regulated. Therefore, recognition of informal waste workers activities will support sustainable CDW management,

The study further revealed that despite the lack of effective legislation, CDW reuse is effectively practiced in some Nigerian states. One example is Anambra state of Nigeria. A policy stakeholder opined that one can be arrested for dumping waste in an undesignated place in Anambra State. This denotes that there is a recent wake up call to waste management in some Nigerian states.

The research findings revealed that there are challenges to the implementation of some global best practices in developing countries because the composition of CDW differs from that of developed countries in that developed countries typically produces inert waste like stones, sand, dust, while the developing countries produce organic waste while solid waste is a mixture of construction and other waste materials. This renders it unproductive to employ those management systems used in developed countries.

Moreover, the findings revealed that what works in other countries might not apply in Nigeria, as Nigeria is different in terms of political system, hence, the approach might be different. For example, godfatherim has eaten deep into the political system, leading to lack of proper governance and the lack of enforcement of local laws and byelaws (as indicated in Section 8.2. Hence, participants argued that until Nigeria experience political reforms where power control is evenly distributed and the ruling party is accountable for all their actions and inactions, then the effects will be evidenced in the construction sector as well.

9.3.3 Objective 3

Investigate the barriers to Re-use and Recycling of CDW in Nigeria

The research findings revealed that starting construction before complete documentation, inadequate regulation, lack of policy implementation and lack of awareness about reuse and recycling as major barrier to recycle and reuse in Nigeria. Awareness of the benefits of reuse/recycling is generally high amongst construction professionals but low among the citizens. Moreover, the Nigerian recycling market is immature (supported by 68.9% construction stakeholders), and there are few factories, located mostly in urban areas of Abuja capital territory, Lagos, Oyo, Ogun, and Edo state. Waste minimization at source is rarely practiced, coupled with the belief in end-pipe treatment. There are also fears/concerns about the quality of recycled products in Nigeria.

Improved policies and proper implementation are vital to sustainable CDW management. Moreover, education could provide a useful tool to increase the likelihood that people will recycle, especially in an environment where waste inevitability culture persists. There is need for government to investigate the state of technical colleges in Nigeria as professionals and artisans require comprehensive training to address waste management challenges. Nigeria possesses a wealth of manpower; however, unemployment among the youth remains one of the many hindrances to national development. This issue can be addressed through the establishment of repositories for technical and vocational education.

The Nigerian construction industry also relies abundantly on the use of virgin material. 61.2% of construction stakeholders highlighted the loss of natural resources as a major effect. To discourage this, the construction stakeholders recommended: providing incentives for waste minimization, increasing dump/tipping fines, and raising the cost of virgin materials as local measures to encourage reuse/recycling.

In Nigeria, waste pickers sell their products to middlemen, who in turn, sell to manufacturing industries. Providing incentives to informal waste workers is a way of protecting them from the exploitation of middlemen. Placing financial incentives will strongly support recycling for the country to transit from predominantly informal recycling to the full involvement of policy makers.

Further findings revealed that there are no specific financial and legal causes of waste. This calls for further investigation into the relationship between financial and legal aspects and their influence on waste generation and management.

The barrier opinion of the various stakeholders can be summarized as follows:

1. The construction stakeholders identified the following key policy issues according to their importance: (1) Incomplete documentation, (2) insufficient regulation, (3) lack of policy implementations, and (4) lack of awareness about CDW management.
2. The policy stakeholders identified (1) insufficient regulation (2) lack of policy implementations, (3) policy reforms to include CDW reuse and recognition of informal waste, and (4) lack of interest of policy makers.

3. The informal waste workers identified the following policy related issues: (1) lack of interest of policy makers in waste management through reuse and recycling.

9.3.4 Objective 4

Identify the drivers for effective CDW management in Nigeria.

The following drivers to the barriers listed above were suggested by stakeholders:

- Government recognition and inclusion of informal waste workers was suggested: the waste workers suggested that the government should include them in her agenda by recognizing and regulating them as they play an important role in material recovery, transportation, reuse, and recycling in Nigeria. Hence, they are involved in environmentally friendly activities.
- government to subsidize the cost of materials and monetary incentives or financial support to the informal waste workers: This could include providing loans whether they meet the usual credentials to apply for loans or not.
- government to position all the informal waste workers in a permanent site: They believe that positioning them together in a permanent site will help to provide better business skills, help to integrate with the public and to secure more quality and quantity of reusable and recyclable materials.
- government to provide informal waste workers with machines to carry out work mechanically: They believed this would help improve the finished products' quality by providing technologies that will add value to finished products before sales. This will also improve their social status and their working conditions.

- government to repair existing roads and provide constant electricity: This will improve transportation of their waste materials from the production sites to the final consumers.
- Regular public sensitization awareness on the importance of recycling was also suggested: This may come in the form of organizing environmental orientation programs for schools and town hall meetings, sensitizing the public on the importance of taking up a sound solid waste management practice. This can facilitate the implementation of effective and sustainable solid waste management practices in both rural and urban areas.
- Provision of gift and food items as an incentive to support recycling: A recycling SME suggested providing gift and food items to primary school children as a form of sensitization in the peri- urban areas. This helps in communicating the message in a way and manner they will understand.
- Government to impute waste management into the school curriculum right from primary up to tertiary education: This is believed to help to inculcate waste management practices in individuals early on time.
- There should be a public private partnership with government and private recycling companies: they believe that waste workers associations function best when included by municipals

The emphasis here suggests that any comprehensive plan on CDW reuse/recycling in Nigeria should include the Legal, technical, social, and financial factors. Being in the forefront of CDW reuse and recycling, there is the need to explore the role of informal waste workers in CDW management in Nigeria. However, as they are generally not socially accepted in Nigeria and their job is categorized as low grade, their "recognition" warranted further analysis - this was done using the theory of Recognition. The Theory of Recognition, developed by Axel Honneth (1995), is based on the idea that recognition is essential for human flourishing and social cohesion.

9.3.5 Objective 5

Evaluate the role of informal waste workers in reuse and recycling of CDW in Nigeria.

Informal waste workers play a crucial role in CDW reuse and recycling in Nigeria. The informal waste workers collect diverse types of waste from construction sites, households, and informal settlements and transforming waste to wealth through reuse and recycling. The circular economic activities established in Nigeria have been in the informal recycling sector (though driven by poverty rather than green thinking). However, informal waste workers are generally not socially accepted in Nigeria, and their job is categorized as low grade characterized with manual labor.

Though literature studies refer to all informal waste workers as scavengers (Medina, 2001; Wilson, Velis and Cheeseman, 2006; Nyathi, Olowoyo and Oludare, 2018), this research discovered that they are rather; made up of different groups, which was segregated into a hierarchal order of waste handling from high to low in (terms of the economic benefits)- manufacturing companies, scrap dealers (shop and itinerant), informal waste recyclers, Nigerian waste recycling SME's, middlemen and waste pickers. Different groups within the informal waste management hierarchy think differently and face different problems.

Both construction and policy stakeholders (Section 4.6 and 5.8 respectively) agreed that they are aware of waste pickers (scavengers) and believe that they are an efficient solution to CDW management. Most of the construction stakeholders also recognize their contribution to material recovery. Their lack of fundamental human rights, inadequate access to necessities, unsafe working conditions, poor housing, societal stigma, and economic exploitation collectively contribute to their struggle.

Hence, significant majority, (83.3% construction stakeholders) suggested that the government should take certain actions to support waste pickers in the Nigerian waste management system – they suggested their need of technical education (78.2%), and the need to formalize their role (45.3%).

The informal waste workers who were interviewed identified their major challenge as recognition - a struggle for their rights and solidarity (ability to associate and contribute to community progress without being victimized). This was further analyzed using the Theory of Recognition (Chapter 7). They want to be integrated into society, not viewed as ‘outcast’, and their activities to be recognized and supported by the government. Hence, the key suggestion from informal waste workers is through government recognition of their activities – this will come with financial support, regulation and provision of PPEs. Recognition is important because a significant number of informal waste workers face exploitation from middlemen or waste contractors, who often pay them meagre wages for their labor-intensive work. This economic vulnerability restricts their access to basic physiological needs and poses a barrier to fulfilling their safety needs.

Another great challenge is travelling to their location on existing roads, which are in poor condition especially during periods of heavy downpour. Addressing the physiological and safety needs of informal waste workers in Nigeria is crucial to improving their overall well-being and productivity.

Though recycling is a lucrative business in Nigeria today, there is still a lot of untapped opportunities. The recycling industry in Nigeria is still in its infancy in contrast to what is seen elsewhere around the globe. There is therefore an urgent need for investors to explore the recycling sector and commercialize it.

The key emphasis here is for active government intervention to:

1. Revise existing waste management laws to recognize the activities of informal waste workers.
2. Organize the informal waste workers.
3. Involve both private and public entities in CDW management in Nigeria to help in formalize their activities as they could be trained on waste segregation.
4. Address the physiological and safety needs of informal waste workers in Nigeria.

The study identified certain measures to enhance the roles of waste pickers in CDW management in Nigeria are:

1. Recognition of the roles of informal waste workers in CDW management in Nigeria: Recognition of informal waste workers, especially the waste pickers is also a way to protect from exploitative activities of the middlemen.
2. Improved record keeping: literature review suggest that statistics of waste pickers in Nigeria remains unrecorded (Medina, 2001; Nyathi, Olowoyo and Oludare, 2018). This not only applies to the number of waste workers, but the amount of waste reused/recycled and the environmental benefits.
3. Financial incentives: One keyway to encourage their activities is through financial incentives (supported by 60.9% construction stakeholders). This could be done through establishing formal co-orporative groups, and when their activities are formalized.

4. The reorganization of the activities of the waste pickers ensures that co-orporative groups be created amongst them for easy access to economic incentives provided by the government. Though there are exiting collaborative groups, most of these groups are informal arrangements for collective benefits. The existing groups can be used as a model for reorganization.

9.3.6. Objective 6

Identify the inter-relationships and needs of the informal sector, as a basis for generating a road-map for the recognition of the informal sector in the re-use and recycling of CDW in Nigeria.

The idea here was to further analyze the social challenges related to recognition faced by informal waste workers. Each actor in the informal waste hierarchy faces unique challenges influenced by factors such as infrastructure, policy factors, and market dynamics. The interrelationship and needs of each actor is illustrated in Figure 8.3.

Generally, all the informal waste workers, despite their level in the waste hierarchy faces mockery by the public. Other challenges include: foul odor from the waste, contact diseases, exploitation of informal recyclers is in the form of short payment, Waste recyclers paying many unaccounted levies without the government providing the necessary/basic infrastructures like electricity, water, roads, etc., harassment by some government bodies (tax force) to pay fees and levies, some do not belong to unions as they could not keep up with the union dues, The waste pickers especially lack social acceptance, faces diseases and harassment, foul odor from dump sites (due to contamination of waste). The waste pickers are exploited by the middlemen and scrap dealers. The informal waste recyclers complained about material sourcing.

Key financial challenges faced by informal waste workers are the high cost of materials, operation of waste facilities, local levies and logistic expenses. Local levies affect informal recyclers and scrap dealers (shops), who pay a lot of levies at their business premises. Logistic expenses relate to transport and fuel or their dependence on the itinerant waste buyers to their logistic requirements. The high cost of materials relates to the prices paid by informal recyclers to scrap dealers (shop and itinerant scrap dealers) who in turn must pay for transport and fuel. Operation of waste facilities relates to cost of operating recycling facilities by Nigerian recycling SME's.

9.4 Contributions and Recommendations

9.4.1 Contribution to knowledge

The result of this study has theoretical contribution to the body of knowledge in CDW management and practical implication for the construction industry.

9.4.1.1 Theoretical implications

Revision of existing waste management laws to include reuse and recycling of CDW: For sustainable waste management, the key point suggested in this research is the need for legislative reform to include reuse/recycle of CDW as currently, there exists no industrial standards and specifications that covers CDW reuse and recycling in Nigeria.

Contract documents: The research findings revealed that starting construction before complete documentation is a major barrier to recycle and reuse in Nigeria.

Awareness: Awareness of the benefits of reuse/recycling is generally high amongst construction professionals but low among the citizens.

Revision of Policies on education: Improved policies and proper implementation are vital to sustainable CDW management. Moreover, education could provide a useful tool to increase the likelihood that people will recycle, especially in an environment where waste inevitability culture persists. There is need for government to investigate the state of technical colleges in Nigeria as professionals and artisans require comprehensive training to address waste management challenges.

Revision of existing waste management laws to recognize the activities of informal waste workers: Though literature refers waste workers as scavengers, this research findings discovered that this is not so - they are made up of different groups, which was differentiated into a hierarchal order of waste handling from high to low - manufacturing companies, scrap dealers (shop and itinerant), informal waste recyclers, Nigerian waste recycling SME's, middlemen and waste pickers. Different groups within the informal waste management hierarchy think differently and face different problems. But generally, they want their activities to be recognized and supported by the government. Hence, the key suggestion from informal waste workers is through government recognition of their activities – this will come with financial support, regulation, and provision of PPEs. Waste pickers in particular, wants to be integrated into society, not viewed as 'outcast'. Recognition is important because waste pickers face exploitation from middlemen or waste contractors, who often pay them meagre wages for their labor-intensive work. This economic vulnerability restricts their access to basic physiological needs and poses a barrier to fulfilling their safety needs.

9.4.1.2 Practical implications:

The study findings (presented in Section 8) have both economic and environmental implications for practice. These include.

- *Best waste management approaches:* This study has been able to establish that other waste disposal methods aside from reuse and recycling are not environmentally friendly, therefore, unsustainable. Reuse is more sustainable as it requires less energy and reduces costs compared to new materials. Moreover, reuse reduces greenhouse gas emission, reduces waste, and air pollution.

  Though recycling is a lucrative business in Nigeria today, there is still a lot of untapped opportunities. The recycling industry in Nigeria is still in its infancy in contrast to what is seen elsewhere around the globe. There is therefore an urgent need for investors to explore the recycling sector and commercialize it.
- *Application of global best waste management approaches:* There are challenges to the implementation of some global best practices in Nigeria because of the composition of CDW; solid waste in Nigeria is a mixture of both municipal and construction waste and as well more of organic waste. This renders it unproductive to employ some of those management systems used in developed countries. Moreover, what works in other countries might not apply in Nigeria, as Nigeria is different in terms of political system, hence, the approach might be different.
- *Reuse is a reality*: The study findings revealed that CDW reuse is a reality, as CDW reuse and recycling in Nigeria is mainly carried out by informal waste workers who collect, sort, and process the waste materials in a circular economy principle. As one of the policy stakeholders noted that '*our ecosystem is incomplete without the role of scavengers*'. There

is therefore there is a need for recognizing and supporting them. The study further revealed that despite the lack of effective legislation, CDW reuse is effectively practiced in some Nigerian states. One example is Anambra state of Nigeria. One can be arrested for dumping waste in an undesignated place in Anambra State. Given this development, it is obvious that Nigeria has development potential with regards to its CDW management practices

- With regards to current practices with reuse and recycling, the research findings revealed that on-site reuse is the most practiced reuse method among Nigerian contractors, while the onsite reuse method commonly employed is reuse of excavated soil as backfill.
- The findings reveal a high awareness level among construction practitioners; however, their awareness did not translate into action as evidenced by the high volumes of waste that are generated.
- *Attitude:* The study findings reveal a growing concern over poor standard of CDW management, which results to environmental problems in Nigeria. Though participants revealed concern about the amount of CDW, waste, in Nigeria, is viewed as inevitable. The waste inevitability attitude can be seen as an underlying factor in achieving effective CDW minimization. The study therefore contributes to the theory of planned behavior which suggests that the behavioral intention of an individual is formed by attitudes, subjective norms, and perceived behavioral control (Ajzen, 1985). As the theory holds, perceptions influence attitudes, which determine behavior. The implication is that construction professionals must perceive CDW reuse and recycling as a significant aspect of the construction process and exhibit positive attitudes towards it.

9.4.2 Recommendations

Recommendation for Policy Reform: This study recommends a review of current policies on waste management to include reuse/recycling of CDW. In Nigeria, there is need for policies that regulates both scavenging and waste segregation activities and would also encourage foreign investment in waste recycling.

Previous literature on the current CDW management system indicate that Nigeria depends on landfilling (Ogunmakinde, Sher and Maund, 2019), hence, does not meet with global environmental expectations (leading to environmental impacts highlighted in section 8.2.1). This leads to expectations that a paradigm shifts from the current end pipe approach to reduce, reuse, recycle, treat, and dispose is required. This view is substantiated by the lack of supporting legislation, both at local and national levels. Following the examples of developing countries, policy reform could encourage the practice of more advanced waste design methods like BIM, selective deconstruction, prefabrication, and circular economy.

However, what works in one country might not be suitable in another.

The current policy implementation follows a top-down approach that excludes the ground level actors (the informal waste workers) in policy matters. This study has shown that informal waste workers play a vital role in reuse/recycle of CDW in Nigeria. There is a need to create legislation that would empower and engage them. In addition, they should be incorporated in waste segregation. The informal waste workers struggle to satisfy their physiological needs of food, water, shelter, clothing, and healthcare, and their job exposes them to various risks, making safety a critical concern. Governments must protect them through recognition of their activities and formalization of their roles.

Recommendation for Training and Education: Provision of technical education for construction workers and public orientation on benefits of reuse/recycling of CDW has been recommended. Legislation will be required to implement formal educational reforms. The training of informal waste workers on waste sorting and segregation is a vital education. There is also a need for training in advanced methods like BIM, selective deconstruction, and circular economy. These are recommended professional training for construction workers and possibly the policy stakeholders too.

Reforms in informal education will also be valuable; for example, a preparation talks on waste management before the start of every construction and demolition activity, continuous professional development courses, knowledge exchange between professional in Nigeria.

Recommendation for involvement of professional institutions for sustainable CDW management:

The study recommends the involvement of professional institutions including the regulatory councils, professional institutions like the Nigerian institute of Architects NIA, Nigerian institute of quantity surveyors NIQS, Nigerian institute of civil engineers NICE, Nigerian institute of building (NIOB), etc. This professional bodies represents their members in lobbying government about relevant legislation, (such as reuse and recycling of CDW), provide career support and opportunities for students, graduates and other construction practitioners and to promote science and practice of building technology in Nigeria.

Currently, the Nigerian construction industry relies on industry standards and specifications (Egwunatum *et al.*, 2022). However, there is currently no standard that specifically covers CDW materials. This study recommends the incorporation of CDW in NIS standards.

9.5 Limitation of research

The research is on reuse and recycling of CDW in Nigeria with a particular focus on the role of informal waste workers in facilitating it. However, due to stigma on waste pickers as a result of the lack of awareness about the wealth in waste, funding bodies were skeptical in accepting the topic and releasing fund for the research.

Due to bad roads, transport to and from the location was very difficult. After reaching the location, it was not easy to access the waste reclamation area and observe/speak to the waste workers. Potential participants were afraid of sanctioning by the union if they give certain information. Some were also concerned that giving out information could potentially harm their business. This was because they were concerned about the true nature of the research, while others were in doubt of what the information would be used for despite the provided explanatory information on the research. They believed that certain information when given out will affect the business in a sense that people will know the secrets of the business which will jeopardize their profits in the long run. This mistrust arises from the fact that most of the waste workers do not understand the concept of research or the purpose of research. Some are just not interested due to ignorance.

The language barrier was also a problem (those who could not speak English nor Igbo were not interviewed because of lack of an interpreter.

The aspect of waste studied in this research is limited to material waste. This now provides the opportunity for future research on other types of CDW in Nigeria and similar developing countries.

9.6 Future research

There is need for research to bridge culture and social behaviors that encourage waste. Research and development in CDW management should cut across the social, financial, policy and technical factors identified in this study. With the recent deregulation of petroleum products in Nigeria, the cost of transporting waste to landfill is exorbitant, more research is required on on-site reuse of CDW. There is also need for research on waste efficient design that suits Nigeran culture and environment. Imported technology needs to be adapted well to our culture and environment. The incorporation of BIM, circular economy, and selective deconstruction in our waste management plan needs further research. As observed in this study, what works abroad may not be applicable to Nigeria. Adaptation of foreign knowledge to suit our local environment requires both quantitative and qualitative research. There is also a need for research in areas: of incorporating recycled products to increase our local content in development, incorporation of environmental management in national development plan, incorporating waste pickers into formal recycling of CDW, and adaptation of foreign technology to meet our local needs.

Further findings revealed that there are no specific financial and legal causes of waste. This calls for further investigation into the relationship between financial and legal aspects and their influence on waste generation and management.

9.7 Final reflection

The study employed a mixed method approach involving the synthesis of related literature on CDW management, questionnaire survey, qualitative interview and proxy ethnography to investigate the potential for reuse and recycling of CDW in Nigeria with specific focus on the role of informal waste workers in facilitating this.

This study shows that large amount of CDW is produced and discarded by the Nigerian construction industry. The standard of waste management in Nigeria is still poor and outdated, with poor collection and disposal systems, and as a result, higher proportion of the waste end in landfill, leading to environmental degradation and health hazards.

Global CDW management strategies (presented according to their priority in tackling waste), includes CDW management through reduce, reuse, recycle, treat, and dispose. Findings revealed that there are challenges to the implementation global best practices in Nigeria because the composition of CDW differs to that of developed countries in that solid waste in Nigeria is a mixture of municipal and construction waste and the waste is more of organic waste. This renders it unproductive to employ those management systems used in developed countries. Moreover, what works in other countries might not apply in Nigeria, as Nigeria is different in terms of political systems.

Waste reuse requires less energy and costs; it releases less pollution, and it preserves the embodied energy originally used to manufacture the item. It also supports achieving zero waste goals.

The Nigerian construction industry mostly practice onsite reuse while the onsite reuse method mostly practiced is reuse of excavated soil for landscaping.

The data collected shows that studies on reuse/recycle of CDW in Nigeria is limited: most of the political appointees in charge of waste management in Nigeria have limited knowledge of CDW recycle/reuse and general CDW management. Though there are industrial standards and specifications followed by the Nigerian construction sector, but none covers CDW reuse/recycle. However, CDW management in Nigeria is reliant on efforts of the informal waste workers who collect, sort, reuse and recycle this waste materials using the circular economy principle. With limited education, the ability of waste recyclers to create new products using offcuts is a unique quality. Despite this, they are generally not socially accepted in Nigeria and their job categorized as low grade. Hence, this study suggested government recognition of informal waste workers, this will come with financial support to assist in the provision of capital and provision of recycling facilities and PPEs to safely carry out their work. This warranted further analysis using Axel Honneth's (1995) theory of Recognition.

This research findings revealed that waste management strategies currently applied in Nigeria is mostly landfilling. But the study also revealed strong awareness about reuse and recycling of CDW among construction stakeholders in Nigeria. However, despite high awareness amongst the professional, many of them do little or nothing about waste due to the waste inevitability culture prevalent amongst Nigerians. Though there are existing waste management laws, most of the policy stakeholders believe that the willingness to implement these laws is lacking.

This study therefore suggested public enlightenment about the wealth in waste, policy revision to include CDW reuse and recycling and recognition of informal waste workers at both local and national levels. Social recognition means that their role should be recognized as noble, and their rightful privileges (such as good roads, electricity, water, etc.) accorded them as they greatly contribute to resource recovery and job creation.

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APPENDICES

Appendix A –Questionnaire Survey

I am currently a full-time doctoral researcher at Cardiff University, Cardiff, Wales in the UK, and my research is titled "**Impact of reuse and recycling of construction and demolition waste (CDW) on construction projects in Nigeria**". The research is aimed at investigating the potential for reuse and recycling of CDW in Nigeria with specific focus on the role of informal waste workers in facilitating this.

It is common for construction and demolition waste to lie fallow along major roads, empty plots of land and even waterways which impacts the environment, economy, and society adversely. Though some of these wastes are managed remotely by the informal waste workers for economic purposes, current legislations are driving construction practitioners to seek better of managing CDW using more sustainable means such as reuse and recycling.

The questionnaire below is the foundation of my PhD research and the main purpose of this questionnaire is to solicit your opinion on the formal way of reuse and recycling of (CDW) in Nigeria. I therefore solicit for the input of all professionals in the built environment (contractors, architects, quantity & land surveyors, engineers, project managers, among others). **Please be assured that this research project is strictly for the purpose of research and all individual responses will be anonymized, with any personal data kept confidential.**

It will take less than 20 minutes to complete the questionnaire. Please contact me through my details below in case you need further clarification or details. Your participation in this study is entirely voluntary, and you may withdraw from the study at any time without giving a reason. This research project is being supervised by Dr Vicki Stevenson (stevensonv@cardiff.ac.uk) and Dr Christopher Whitman (whitmancj@cardiff.ac.uk) as representatives of Cardiff University and you can always contact them through their emails above should you wish to. Please provide details in the last section of the questionnaire if you wish to receive this research's findings.

Thanks for your anticipated help.

Chinedu Esther Onyekwere

PhD student, Cardiff University, Wales.UK.

Email: onyekwereCE@cardiff.ac.uk;

CONSENT FORM

By ticking "I agree" below, you are indicating that you are at least 18 years old, have read and understand the consent information and agree to participate in the research study.

- I agree.

THE QUESTIONAIRE

REUSE AND RECYCLING OF CONSTRUCTION AND DEMOLITION WASTE (CDW)

1. **Background information**
    - Position/Role (Contractor, architect, quantity surveyor, Land surveyor, project manager, planner)

      …………………………………………….…………….
    - No of employees in the company you work for (please, tick only one box)
        i. Less than 100 ii. 100-499 iii. 500-999 iv. Over 1,000
2. **Solution to construction and demolition waste (CDW) – current and potential**

    2a. Are you aware of the amount of construction and demolition waste CDW your company produces? Yes/ No

    2b. Are you concerned about the amount of CDW produced? Yes/ No

3. Do you believe that reuse/recycling have the potential to manage substantial amount of construction waste in Nigerian construction industry? Yes / No

Construction and demolition waste (CDW) Types

4. In your opinion, which of the following materials has the highest volume of wastage at the construction site? Please rank from 1-5 below, where 1-indicates never wasted, 2-indicates insignificant waste, 3-denotes minimal waste, 4-denotes significant waste and 5-denotes most wasted material.

ID		**Never wasted**	**Insignificant waste**	**Minimal waste**	**significant wasted**	**Most wasted**
i	Packaging	1	2	3	4	5
ii	Landscaping (Topsoil, excavation, asphalt/tarmac, geotextiles)	1	2	3	4	5
iii	Metal (roofing sheets, nails, rods, binding wires)	1	2	3	4	5
iv	Plastics (including PVC)	1	2	3	4	5
v	Glass/tiles/ ceramics	1	2	3	4	5
vi	Timber/wood products	1	2	3	4	5
vii	Masonry (concrete, bricks, mortar)	1	2	3	4	5
viii	Plaster boards	1	2	3	4	5
ix	Electric components (light fittings, bulb, switches, sockets, etc.)	1	2	3	4	5
x	Insulation	1	2	3	4	5
xi	Mechanical components (elevators, NVAC, etc.)	1	2	3	4	5
xii	Plastic foam (e.g. EDPM (ethylene propylene diene monomer), PUR (polyurethane rigid foam)	1	2	3	4	5

Causes of construction and demolition waste (CDW)

5. The following are possible causes of construction and demolition waste. In your opinion, please rank from 1-5, where 1 indicates ‘not a waste cause, 2-minor cause, 3-insignificant cause, 4-denotes significant cause and 5-denotes major cause.

ID		**Not a cause**	**Minor cause**	**insignificant cause**	**Significant cause**	**Major cause**
	Physical causes					
i	Offcuts from material cutting	1	2	3	4	5
ii	Unavailability of storage space	1	2	3	4	5

iii	Unused materials and products	1	2	3	4	5
iv	Building design	1	2	3	4	5
v	Accidental damage	1	2	3	4	5
	Cultural causes					
i	Non collaborative culture	1	2	3	4	5
ii	Starting construction without completing documentation	1	2	3	4	5
iii	Belief in waste inevitability culture	1	2	3	4	5

Others (pls state below),

…………………………………………………………………………………………………

…………………………………………………………………………………………………

Waste reduction strategies

6. Which of the following waste reduction strategies has your company applied in your recent projects? Please rank from 1-5 where 1denotes never been applied, 2 denotes rarely applied, 3denotes sometimes applied, 4 denotes mostly applied, and 5 denotes always applied.

ID		**Never applied**	**rarely applied**	**Sometimes applied**	**mostly applied**	**always applied**
i	Prefabrication	1	2	3	4	5
ii	Design for deconstruction	1	2	3	4	5
iii	Digital construction (building information modeling (BIM)	1	2	3	4	5
iv	Circular economy	1	2	3	4	5
v	Use of standard materials **sizes** to reduce offcuts	1	2	3	4	5
vi	Specification of reused/recycled materials	1	2	3	4	5

Others, please state below

…………………………………………………………………………………………………

…………………………………………………………………………………………………

Strategies that best supports Construction and demolition waste (CDW) Reuse

7. From the scale 1-5, rank the following driver to reuse/recycling of construction and demolition waste (CDW), where 1 denotes not a driver, 2 denotes minor driver, 3 denotes insignificant driver, 4-denotes significant driver and 5-denotes major driver.

ID		**Not a driver**	**minor driver**	**insignificant driver**	**Significant driver**	**major driver**
i	Provision of waste skips	1	2	3	4	5
ii	Incentives for waste minimization practices	1	2	3	4	5
iii	Technical education to workers	1	2	3	4	5
iv	Introduction of selective deconstruction	1	2	3	4	5
v	Increased landfill levy	1	2	3	4	5
vi	Increased taxation on natural aggregates	1	2	3	4	5
vii	Increased Dumping/tipping fines	1	2	3	4	5
viii	Increased cost of virgin materials	1	2	3	4	5
ix	Formalizing scavengers' role	1	2	3	4	5

Others (pls, state below)

……………………………………………………………………………………………

……………………………………………………………………………………………

8. Are you aware that informal waste pickers (Scavengers) can act as possible means of reuse/recycling of construction and demolition waste (CDW) in Nigeria?
    - o I am aware of waste pickers (scavengers) and believe that they recover substantial amounts of recyclable and reusable materials.
    - o I am aware of waste pickers (scavengers) but believe that they are not an efficient solution.
    - o I am aware of waste pickers (scavengers) but believe that they are a problem.
    - o I am not aware of waste pickers (scavengers)
9. Do you believe that substantial financial savings could be made from effective construction and demolition waste management? Yes/ No

Barriers to construction and demolition waste (CDW) Ruse/recycling

10. The following are potential major barriers to reuse and recycling of construction and demolition waste (CDW). In your opinion, please rank from 1-5 where 1-denotes no

barrier, 2 denotes rare barrier 3denotes minimum barrier and 4-significant barrier and 5-maximum barrier.

ID		No barrier	Insignificant barrier	Minimum barrier	Significant barrier	Maximum barrier
i	extra cost of reuse/recycling	1	2	3	4	5
ii	Distance	1	2	3	4	5
iii	Availability of Recycling facilities	1	2	3	4	5
iv	Space to separate /store materials	1	2	3	4	5
vi	Insufficient regulations to support CDW management	1	2	3	4	5
vii	Not adaptable for all waste streams	1	2	3	4	5
viii	Uncertainty about quality/acceptance of reused/ recycled materials	1	2	3	4	5
x	Organization of transport to different reclamation sites	1	2	3	4	5
xi	Immature recycling market	1	2	3	4	5
xii	It is an end of pipe treatment	1	2	3	4	5

Others (Pls state below…………………………………………………

11. How often do the company you work for put the following reuse methods into practice? Please rank from1-5 below where 1denotes never practiced, 2 denotes rarely practiced and 3 denotes sometimes practiced, 4 denotes mostly practiced and 5 denotes always applied.

Wood	**Never practiced**	**Rarely practiced**	**Sometimes applied**	**Mostly practiced**	**Always applied**
Reuse of wood waste as mulch	1	2	3	4	5
Reclaimed timber for formwork, scaffolding, EWS(earth work support)	1	2	3	4	5
Recycled Concrete Hardcore					
Filling of potholes on roads	1	2	3	4	5
Production of secondary aggregates for new concrete (RCA)	1	2	3	4	5
Excavated materials					

Excavated soil for landscaping	1	2	3	4	5
Metals					
Reuse for making tools	1	2	3	4	5
general					
Reuse of offcuts	1	2	3	4	5

Other (pls, state below……………………………………………………………………………

Waste treatment/management strategies

12. Below is a list of waste management strategies. Please rank from 1-5 the extent to which each strategy has been applied by your company in your recent projects, where 1 denotes never been used, 2 denotes rarely been used, 3 denotes sometimes used, 4 mostly used and 5 denotes always used in all projects.

1D		**Never applied**	**rarely applied**	**Sometimes applied**	**mostly applied**	**always applied**
i	Reuse (onsite reuse)	1	2	3	4	5
ii	Recycling	1	2	3	4	5
iii	Energy Recovery	1	2	3	4	5
iv	landfilling	1	2	3	4	5
v	Incineration	1	2	3	4	5
vi	Use of scavengers	1	2	3	4	5
vii	Informal waste disposal	1	2	3	4	5

Other (please specify below)

………………………………………………………………………………

13. Do your company have a waste management plan? Yes/ No

Effects of factors on Nigerian waste management sector

14. The following factors may potentially enhance CDW management in the Nigerian construction sector. In your opinion, please rank from1-5 where 1-denotes no effect, 2-

denotes insignificant effect, 3-denotes minimum effect and 4-denotes significant effect and 5-maximum effect.

ID		**No effect**	**Insignificant effect**	**Minimum effect**	**Significant effect**	**Maximum effect**
i	Provision of technological resources to successfully carry out CDW management	1	2	3	4	5
ii	Provision of financial resources to successfully carry out CDW management	1	2	3	4	5
iii	Interest of policy makers in matters concerning CDW management	1	2	3	4	5
iv	Interest of public in matters concerning CDW management	1	2	3	4	5
v	Incorporating waste management in the curriculum of tertiary education sectors	1	2	3	4	5
x	Elimination of godfatherism (giving jobs to competent persons instead)	1	2	3	4	5

15. Any other measures to enhance construction waste reuse/recycling in Nigeria? Pls state below

    ………………………………………………………………………………………………

Environmental impacts of CDW

16. In your opinion, please rank the effects of the following construction and demolition waste on the **environment**. Please rank from 1-5, where I-denotes no effect, 2-denotes insignificant effect, 3-denotes minimum effect, 4-denotes significant effect and 5-denotes major effect.

ID		**No effect**	**minimal effect**	**insignificant effect**	**Significant effect**	**Major effect**
i	Leachates (poisonous liquids from landfill)	1	2	3	4	5
ii	Dust	1	2	3	4	5
iii	Aesthetic problems	1	2	3	4	5

iv	Loss of natural resources	1	2	3	4	5
v	Don't Biodegrade (e.g plastics)	1	2	3	4	5

Others (please state)

………………………………………………………………………………………………………

………………………………………………………………………………………………………

Economic impacts of CDW

17. In your opinion, rank the effects of the following economic impacts of construction and demolition waste (CDW) on construction businesses.

ID		**No impact**	**insignificant impacts**	**Minimum impact**	**Significant impact**	**Major impact**
i	Purchase of unused materials	1	2	3	4	5
ii	Payment for storage and transport of unused materials	1	2	3	4	5
iii	Payment for disposal of unused materials	1	2	3	4	5
iv	Cost of cleaning up CDW in the environs	1	2	3	4	5
v	Cost of cleaning up CDW in the project site	1	2	3	4	5

Others (please state)

………………………………………………………………………………………………………

…………………………………………………………………………………………

18. If you are willing to participate in an interview on this topic or receive the result of the analysis nor both, please provide your name and contact details here:

Name:

Email:

Telephone:

Appendix B – INTERVIEW WITH POLICY STAKEHOLDERS

INTERVIEW QUESTIONS

A. (POLICY MAKERS)

1. It is observed that municipal solid management system in Nigeria is effective. What do you think is the reason why construction and demolition waste (CDW) management sector is not effective? How can the construction waste management sector be made effective?
2. It is understood that there is no policy currently in place to enhance CDW reuse/recycling, reduce illegal CDW disposal and divert CDW from landfills? Why is the existing policy not encouraging reuse and recycling of CDW? What can be done to enhance CDW reuse/recycling in Nigeria?
3. Are there any attempts made to stop the illegal dumping of CDW?
4. Do you think cost is a barrier to reuse and recycling of construction and demolition waste?
5. Are there any economic incentives to support small scale companies to reuse and recycle CDW?
6. It is generally observed that scavengers act as part of socio-economic system in Nigerian construction industry even though their working condition is not conducive to good living. What do you think can be done to alleviate their working conditions and include them in the waste management system and act as a pathway for transition into more sustainable CDW management?

APPENDIX C: ETHNOGRAPHIC INTERVIEW WITH INFORMAL WASTE WORKERS IN NIGERIA

ETHNOGRAPHIC INTERVIEW QUESTIONS

B. (Informal waste workers)

1. Do you like this Job?
2. Why did you choose this job? Pls explain.
3. How long have you been doing this job?
4. What time do you usually work?
5. What type of items do you usually sort for?
6. Briefly, tell us the importance of this materials you sort and why you prefer them to other materials?
7. How many kg do you sort in a day? When sold, can it be enough to cater for you and your family in a day?
8. Do you belong to an organization, a group of associations of waste pickers? If so, please state……………Do you work for yourself or being managed by someone?
9. Is the association registered with state or local government?
10. If there are no waste pickers association, will you like to have one?
11. What are some of the challenges/difficulties you face in your work (Bites/attacks from insects, animal/health crises/injuries/accidents, others (pls state)?
12. Do you believe cost is a driver to CDW reuse/recycling?
13. What do you think can be done to remedy or improve your working conditions?
14. Describe the process of managing this waste from the point of collection resale?
15. Do you pay any money to the authority before you are allowed to work in the area?
16. Do you get harassment of any sort from the authorities or people in your working area?
17. Do you receive any sort of exploitation from buyers of your recyclables?
18. What do you think can be done to improve CDW reuse and recycling in Nigeria?

APPENDIX D: RESEARCH ETHICS APPROVAL FORM

WELSH SCHOOL OF ARCHITECTURE
ETHICS APPROVAL FORM FOR STAFF AND PHD/MPHIL PROJECTS

wsa

Tick one box:	STAFF	● PHD/MPHIL
Title of project:	IMPACT OF REUSE AND RECYCLING OF CONSTRUCTION AND DEMOLITION WASTE ON CONSTRUCTION PROJECTS IN NIGERIA	
Name of researcher(s):	CHINEDU ESTHER ONYEKWERE	
Name of principal investigator	DR VICKI STEPHENSON	
Contact e-mail address:	onyekwereCE@cardiff.ac.uk	
Date:	14/8 /2020	

Participants		**YES**	**NO**	**N/A**
Does the research involve participants from any of the following groups?	• Children (under 16 years of age)		No	
	• People with learning difficulties		No	
	• Patients (NHS approval is required)		No	
	• People in custody		No	
	• People engaged in illegal activities		No	
	• Vulnerable elderly people		No	
	• Any other vulnerable group not listed here		No	
• When working with children: I have read the Interim Guidance for Researchers Working with Children and Young People (http://www.cardiff.ac.uk/archi/ethics_committee.php)				n/a

Consent Procedure	**YES**	**NO**	**N/A**
• Will you describe the research process to participants in advance, so that they are informed about what to expect?	yes		
• Will you tell participants that their participation is voluntary?	yes		
• Will you tell participants that they may withdraw from the research at any time and for any reason?	yes		
• Will you obtain valid consent from participants? (specify how consent will be obtained in Box A)[1]	yes		
• Will you give participants the option of omitting questions they do not want to answer?	yes		

[1] If any non-anonymous and/or personalised data be generated or stored, *written consent* is required.

• If the research is observational, will you ask participants for their consent to being observed?	yes		
• If the research involves photography or other audio-visual recording, will you ask participants for their consent to being photographed / recorded and for its use/publication?	yes		

Possible Harm to Participants	**YES**	**NO**	**N/A**
• Is there any realistic risk of any participants experiencing either physical or psychological distress or discomfort?		no	
• Is there any realistic risk of any participants experience a detriment to their interests as a result of participation?		no	

Data Protection		**YES**	**NO**	**N/A**
• Will any non-anonymous and/or personalised data be generated or stored?		x		
• If the research involves nonanonymous and/or personalised data, will you:	• gain verbal consent from the participants	x		
	• allow the participants the option of anonymity for all or part of the information they provide	x		

Health and Safety	**YES**	
Does the research meet the requirements of the University's Health & Safety policies? (http://www.cf.ac.uk/osheu/index.html)	yes	

Research Governance	**YES**	**NO**	**N/A**
Does your study include the use of a drug? You need to contact Research Governance before submission (resgov@cf.ac.uk)		no	
Does the study involve the collection or use of human tissue? You need to contact the Human Tissue Act team before submission (hta@cf.ac.uk)		no	

Prevent Duty	**YES**	
Has due regard be given to the 'Prevent duty', in particular to prevent anyone being drawn into terrorism? https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/445916/Prevent_Duty_Guidance_For_Higher_Education__England__Wales_.pdf http://www.cardiff.ac.uk/publicinformation/policies-and-procedures/freedom-of-speech	yes	

If any of the shaded boxes have been ticked, you must explain in Box A how the ethical issues are addressed. If none of the boxes have been ticked, you must still provide the following information.
The list of ethical issues on this form is not exhaustive; if you are aware of any other ethical issues you need to make the SREC aware of them.

Box A	The Project (provide all the information listed below in a separate attachment)

1. Title of Project
2. Purpose of the project and its academic rationale
3. Brief description of methods and measurements
4. Participants: recruitment methods, number, age, gender, exclusion/inclusion criteria
5. Consent and participation information arrangements - please attached consent forms if they are to be used
6. A clear and concise statement of the ethical considerations raised by the project and how is dealt with them
7. Estimated start date and duration of project

All information must be submitted along with this form to the School Research Ethics Committee for consideration

Researcher's declaration (tick as appropriate)	
• I consider this project to have **negligible ethical implications** (*can only be used if none of the grey areas of the checklist have been ticked*).	yes
• I consider this project research to have **some ethical implications**.	
• I consider this project to have **significant ethical implications**	

Signature	CEO	**Name:**	Chinedu Esther Onyekwere	**Date**	**4/12/20**
Researcher or MPhil/PhD student					
Signature	V. Stevenson	**Name**	Vicki Stevenson	**Date**	**7/12/20**
Lead investigator or supervisor					

Advice from the School Research Ethics Committee

Since non-anonymised data will be generated, the applicant needs to be fully aware of the data protection regulations in the UK and in the country where the data is collected from.
The research is dependent on the completion of the relevant risk assessments and the incorporation of any arising comments from the School's Health and Safety Officer.

STATEMENT OF ETHICAL APPROVAL

This project had been considered using agreed Departmental procedures and is now approved.

Signature **Name** Eshrar Latif **Date 12.12.20**

Signed on behalf of the Chair, School Research Ethics Committee due to conflict of interest.

BOX A:

THE PROJECT

1. **PROJECT TITLE**: IMPACT OF REUSE AND RECYCLING OF CONSTRUCTION AND DENOLITION WASTE ON CONSTRUCTION PROJECTS IN NIGERIA
2. **PURPOSE OF THE RESEARCH**: It is a common scene for construction and demolition waste (CDW) to lie fallow along major roads, completed sites and even waterways which impacts the environment, economy, and society adversely. Though some of these wastes are managed remotely by the informal waste workers for economic purposes. Current legislation is driving construction practitioners to seek better ways of managing CDW using more sustainable means such as reuse and recycling. Therefore, this research is aimed at investigating the potential for reuse and recycling of construction and demolition waste (CDW) in Nigeria with specific focus on the role of informal waste workers in facilitating this. Under this wider scope, the research aims to evaluate the economic viability of construction and demolition waste reuse in Nigeria.

   The purpose of observation and interview is to gather the opinion of waste workers on the barriers to reuse and recycling of construction and demolition waste while observing how construction waste is being collected, processed, and reuse/recycled informally in Nigeria.

   The research field trip is geared towards achieving the above aim and will be undertaken by proxy by a contact of the researcher who lives in Nigeria.

   The research field trip will be conducted in Nigeria (Aba, Abia State precisely). Aba is a commercial City of south-eastern

Nigeria where informal waste recycling is predominant. Informal economic activities are extensively growing and accepted in the City of Aba. It is also vital to the livelihood of many urban residents, especially when the government is not able to provide safety nets to sustain many households above poverty level. Therefore, continuous exclusion of the informal sector is pointless.

Data will be collected through Interviews and Ethnographic study (by proxy) of the business activities of informal waste pickers (also known as scavengers) in their business premises. By proxy means technologically mediated interactions taking place in real worlds, meaning that the physical presence of the ethnographer among the people being studied is not essential. Ethnography allows the researcher to get a subjective, adventurous insider's view of reality! It allows data to emerge naturally and in an unforced way. The researcher intends to observe types/quality of construction materials being collected and sorted by the informal waste pickers, how it is being sorted and prepared for reuse and recycling, how much profit is being made from these materials, how they are being reused. etc. All other information to be discovered at the collection centre as it unfolds. Due to COVID travel restrictions, the observation will be done by proxy (delegating the ethnographer's activity to an academic support staff in the research setting).

3. **BRIEF DESCRIPTION OF METHODS AND MEASUREMENT:**

(a). **Ethnography**: Ethnography relies on observation as a method of data collection. The researcher observes the activities of the informal waste pickers, taking records of the activities. Due to COVID travel restrictions, the observation will be done by proxy (a support staff using technical devices like audio and video recorder, cameras for taking pictures - this will be done retrospectively using photo manipulation software to blur or mask faces on any images the researcher intends to use in the final thesis and other research outputs. The researcher will ask questions and listens to what is said. The researcher thereafter produces a richly written account of what is observed. A support staff has been appointed to take videos and pictures on behalf of the researcher. The support staff is an academic who is versatile/informed in waste management issues. The research benefits from support staff being more able to make contact with the waste pickers than the researcher might have been. This will also ensure compliance and good response rate and gain greater access to information that may be withdrawn from strangers perceived as representing the officials.

(b). **Interview**: Interviews will also be conducted by proxy with informal waste workers and policy makers. It is best to conduct the interviews by proxy as well because most of the informal waste workers are not informed about latest technologies with regards to carrying out zoom calls and the rest. Moreover, some of them have no smart phones to carry out this process. The interview questions have already been prepared (see appendix C). The informal waste workers will be interviewed on their activities' impact on reuse and recycling of CDW.

4. **PARTICIPANTS: RECRUITMENT METHODS, NUMBER, AGE, GENDER,**

EXCLUSION/INCLUSION CRITERIA: The participant in this study are informal waste pickers/scavengers selected in a purposeful sampling method (support staff rely on his own judgment when choosing members) to allow the research question to be addressed appropriately (here, selected participants are informal waste pickers who picks or deals on solely construction waste). These are male and female adults (though the population of the waste pickers is mostly male). The sample size is not normally predetermined. The number of participants depends upon the number required to inform fully all the important elements of the topic being researched. Before conducting the interviews, telephone enquiries will be made to request permission from the organizers of the collection centers. Participants (policy makers and informal waste pickers) would be contacted at their business premises as the organizers will have been contacted prior to the study.

5. **CONSENT AND PARTICIPATION INFORMATION ARRANGEMENTS:** The proposed study does not pose any risk (physical or psychological discomfort or distress) to participants. The interview and observation are solely enquiry about informal reuse and recycling of construction and demolition waste and general waste management in Nigeria. Moreover, the project is void of any type of participant deception, distraction, falsification, or information that is misleading in any way. Data to be collected will not be sensitive as to cause distress, worry or any other unfavorable emotional reactions. The researcher, through her contact person, will gain consent to observe and conduct interviews as well as Inform those to be observed and interviewed about what she is doing and the objectives of her research at the waste collection center.

6. **STATEMENT OF ETHICAL CONSIDERATIONS: The** basic Ethical consideration includes protecting the dignity and rights of all research participants. Deception and distress of any kind to

participants would be avoided. The observation and interview will be conducted truthfully. Consent will be gained prior observation and Participants will freely choose to participate and will also be made to understand that the observation and interview is solely for research purposes and that they are free to withdraw at any point. Moreover, potential risk of safety for the Support staff is addressed by completion of a satisfactory risk assessment.

7. **ESTIMATED START DATE AND DURATION OF PROJECT:** The project is estimated to last for 3 months considering the current situation (January2021-April 2021). The observation will commence by proxy as soon as it has met the necessary approvals.

APPENDIX E: BREAKDOWN OF CHAPTER 4 MATRIX QUESTIONS - PROFESSIONAL ROLE'S CHOICES (Tables 4.15 – 4.89)

BREAKDOWN OF MATRIX QUESTIONS

1. Table 4.15- 4.89 is a breakdown of responses for each demographic group's (professional roles) choice on the matrix question: What are the materials with highest volume of waste at the construction site? The material choices are as follows:

Packaging, landscaping, metal, plastic, glass/tiles/ceramics, timber/wood products, masonry (concrete, brick, mortar), electric component (light fitting, bulb, switches, socket, etc.), insulation, plaster board, mechanical components (elevators, NVAC, etc), plastic foam (e.g EDPM, PUR).

Table 4.15 Packaging waste

	Major wasted	Significant wasted	Minor wasted	Insignificant wasted	Never wasted
Architect	2	4	3	1	0
Contractors	5	5	7	4	0
Quantity surveyors	3	2	8	6	0
Civil engineers	2	2	2	0	2
Project managers	2	2	4	4	2
Estate surveyor	0	0	1	0	0
Non respondents	2	0	1	0	0

Table 4.16. Landscaping waste

	Major wasted	Significant wasted	Minor wasted	Insignificant wasted	Never wasted
Architects	1	3	2	2	4
Contractors	7	6	8	3	0
Quantity surveyors	3	7	7	3	2
Civil engineers	2	1	0	1	3
Project managers	0	2	4	2	5
Estate surveyor	0	0	1	0	0
Non respondents	2	0	1	0	0

Table 4.17 Metal waste

	Major wasted	Significant waste	Minor waste	Insignificant waste	Never wasted
Contractors	1	2	2	2	0
contractors	2	1	14	4	3
Quantity surveyors	2	6	9	6	0
Civil engineers	1	0	1	0	2
Project managers	0	5	4	3	1
Estate surveyor	0	1	0	0	1
Non respondents	0	2	1	0	0

Table 4.18 Plastic waste

	Major wasted	Significant waste	Minor waste	Insignificant waste	Never wasted
Architects	1	2	6	2	0
Contractors	2	5	10	1	1
Quantity surveyors	2	6	5	9	0
Civil engineers	1	0	3	1	1
Project managers	0	5	4	0	0
Estate surveyor	0	1	0	0	0
Non respondents	0	2	0	1	0

Table 4.19 Glass/tiles/ ceramic waste

	Major wasted	Significant waste	Minor waste	Insignificant waste	Never wasted
Architects	1	4	3	0	0
Contractors	1	8	9	1	1
Quantity surveyors	1	8	8	5	0
Civil engineers	0	2	1	0	2
Project managers	3	2	4	2	0
Estate surveyor	0	1	0	0	0
Non respondents	2	0	1	0	0

Table 4.20 Timber/wood products

	Major waste	Significant waste	Minor waste	Insignificant waste	Never wasted
Architects	1	6	0	2	2
Contractors	1	10	5	4	0
Quantity surveyors	1	9	9	3	0
Civil engineers	3	1	1	1	0
Project managers	2	2	2	2	1
Estate surveyor	0	0	0	0	1
Non respondents	2	1	0	0	0

Table 4.21 Masonry (concrete, brick, mortar)

	Major wasted	Significant waste	Minor waste	Insignificant waste	Never waste
Architects	2	3	2	2	1
Contractors	6	9	4	2	1
Quantity surveyors	3	7	7	4	0
Civil engineers	2	1	1	2	0
Project managers	2	4	3	3	0
Estate surveyor	1	0	0	0	0
Non respondents	0	2	0	0	0

Table 4.22. Electric component (light fitting, bulb, switches, socket, etc)

	Major wasted	Significant waste	Minor waste	Insignificant waste	Never wasted
Architects	0	5	0	3	3
Contractors	1	1	11	5	2
Quantity surveyors	0	2	5	11	3
Civil engineers	0	0	1	4	1
Project managers	1	1	7	1	2
Estate surveyor	0	1	0	0	0
Non respondents	0	2	0	1	1

Table 4.23 Insulation

	Major waste	Significant waste	Minor waste	Insignificant waste	Never wasted
Architects	0	2	1	4	0
Contractors	2	2	9	6	1
Quantity surveyors	0	3	2	9	5
Civil engineers	0	2	0	3	0
Project managers	1	1	3	1	1
Estate surveyor	0	0	1	0	0
Non respondents	0	2	0	1	0

Table 4.24 Plaster board

	Major waste	Significant waste	Minor waste	Insignificant waste	Never wasted
Architects	0	6	3	2	0
Contractors	1	6	7	5	1
Quantity surveyors	1	0	12	6	2
Civil engineers	0	1	0	4	0
Project managers	2	3	4	1	0
Estate surveyor	0	0	1	0	0
Non respondents	0	1	0	2	0

Table 4.25 Mechanical components (elevators, NVAC, etc)

	Major waste	Significant waste	Minor waste	Insignificant waste	Never wasted
Architects	0	2	3	2	3
Contractors	1	3	6	4	9
Quantity surveyors	0	2	4	7	9
Civil engineers	0	2	1	1	2
Project managers	0	1	4	1	4
Estate surveyor	0	1	0	0	0
Non respondents	2	0	0	0	1

Table 4.26 Plastic foam (e.g., EDPM, PUR).

	Major wasted	Significant waste	Minor waste	Insignificant waste	Never wasted
Architects	1	3	3	2	2
Contractors	0	6	8	4	3
Quantity surveyors	1	3	4	12	2
Civil engineers	0	3	0	2	1
Project managers	2	6	2	2	0
Estate surveyor	1	0	0	0	0
Non respondents	0	2	0	1	0

2. Table 4.27- 4.34 is a breakdown of responses for each demographic group's (professional roles) choice on the following 8 causes of waste:

The abbreviations used are: Non collaborative culture (NCC), Belief in waste inevitability culture (WIC), starting construction without complete documentation (ID), Accidental damage (AD), building design (BD), Unused materials and products (UMP), Unavailability of storage space (USS), offcuts from material cutting (OMC).

Table 4.27 Non collaborative culture

	Major cause	Significant cause	Minor cause	Insignificant cause	Not a waste cause
Architects	1	4	2	4	1
Contractors	2	11	8	0	1
Quantity surveyors	3	11	7	1	0
Civil engineers	0	1	1	3	0
Project managers	2	0	6	4	0
Estate surveyor	0	0	1	0	0
Non respondents	0	2	0	1	0

Table 4.28 Belief in waste inevitability culture

	Major cause	Significant cause	Minor cause	Insignificant cause	Not a waste cause
Architects	1	4	5	2	0
Contractors	0	11	5	2	1
Quantity surveyors	3	10	7	2	0
Civil engineers	0	2	0	4	0
Project managers	2	4	1	4	0
Estate surveyor	0	0	1	0	0
Non respondents	0	0	3	0	0

Table 4.29 Starting construction without complete documentation.

	Major cause	Significant cause	Minor cause	Insignificant cause	Not a waste cause
Architects	1	5	2	4	2
Contractors	4	17	2	1	1
Quantity surveyors	4	9	6	1	2
Civil engineers	2	1	1	1	0
Project managers	3	4	2	3	2
Estate surveyor	0	0	0	0	1
Non respondents	2	0	0	1	0

Table 4.30 Accidental damage

	Major cause	Significant cause	Minor cause	Insignificant cause	Not a waste cause
Architects	0	2	8	1	1
Contractors	5	10	8	1	0
Quantity surveyors	2	6	12	2	0
Civil engineers	1	0	2	2	0
Project managers	5	3	2	2	1
Estate surveyor	0	1	0	0	0
Non respondents	2	0	0	1	0

Table 4.31 Building design

	Major cause	Significant cause	Minor cause	Insignificant cause	Not a waste cause
Architects	0	3	5	3	2
Contractors	2	12	6	4	2
Quantity surveyors	2	5	7	2	6
Civil engineers	3	0	0	2	1
Project managers	2	5	3	3	2
Estate surveyor	0	0	1	0	0
Non respondents	0	0	2	1	0

Table 4.32 Unused materials and products

	Major cause	Significant cause	Minor cause	Insignificant cause	Not a waste cause
Architects	1	3	6	0	3
Contractors	1	11	0	2	4
Quantity surveyors	5	8	5	3	1
Civil engineers	0	1	0	4	0
Project managers	2	4	1	2	2
Estate surveyor	0	0	0	0	1
Non respondents	0	2	1	0	0

Table 4.33 Unavailability of storage space

	Major cause	Significant cause	Minor cause	Insignificant cause	Not a waste cause
Architects	1	4	3	3	0
Contractors	3	7	6	7	1
Quantity surveyors	2	11	7	2	0
Civil engineers	1	1	1	2	0
Project managers	3	1	4	2	0
Estate surveyor	0	0	0	0	1
Non respondents	1	0	2	0	0

Table 4.34 Offcuts from material cutting

	Major cause	Significant cause	Minor cause	Insignificant cause	Not a waste cause
Architects	1	7	2	2	0
Contractors	5	10	11	1	1
Quantity surveyors	6	9	3	3	2
Civil engineers	1	2	1	1	1
Project managers	1	5	4	1	2
Estate surveyor	0	0	0	0	1
Non respondents	2	1	0	0	0

3. Table 4.35- 4.40 is a breakdown of responses for each demographic group's (professional roles) choice on Waste reduction strategies. The abbreviations adopted are: prefabrication, design for deconstruction, use of standard material sizes to reduce offcuts, circular economy, digital construction and making specifications for the use of reuse/recycled materials (R/R). The choices are as follows:

Table 4.35 Prefabrication

	Always applied	Mostly applied	Sometimes applied	Rarely applied	Never applied
Architects	1	0	3	2	6
Contractors	1	5	7	10	4
Quantity surveyors	4	5	6	5	3
Civil engineers	1	0	2	2	1

Project managers	2	2	2	3	3
Estate surveyor	0	1	0	0	0
Non respondents	1	2	0	0	0

Table 4.36 Design for deconstruction

	Always applied	Mostly applied	Sometimes applied	Rarely applied	Never applied
Architects	2	0	2	7	2
Contractors	3	2	11	6	3
Quantity surveyors	3	2	7	9	1
Civil engineers	1	0	1	3	0
Project managers	2	1	2	4	1
Estate surveyor	0	0	1	0	0
Non respondents	0	3	0	0	0

Table 4.37 Use of standard material sizes to reduce offcuts

	Always applied	Mostly applied	Sometimes applied	Rarely applied	Never applied
Architects	3	6	2	1	2
Contractors	6	7	8	4	0
Quantity surveyors	7	9	7	0	0
Civil engineers	2	1	1	1	0
Project managers	2	7	1	1	1
Estate surveyor	0	0	1	0	0
Non respondents	0	0	3	0	0

Table 4.38 Circular economy

	Always applied	Mostly applied	Sometimes applied	Rarely applied	Never applied
Architects	0	0	8	3	0
Contractors	2	3	12	4	4
Quantity surveyors	3	4	11	4	1
Civil engineers	1	1	2	1	1
Project managers	0	1	6	2	3
Estate surveyor	0	0	0	0	1
Non respondents	0	1	2	0	0

Table 4.39 Digital construction (Building Information Modelling BIM)

	Always applied	Mostly applied	Sometimes applied	Rarely applied	Never applied
Architects	0	2	4	3	3
Contractors	1	2	11	7	3
Quantity surveyors	4	2	8	6	3
Civil engineers	2	0	0	3	0
Project managers	1	5	0	6	0
Estate surveyor	0	0	0	0	1
Non respondents	0	1	0	2	0

Table 4.40 Making specification for the use of reuse/recycled products

	Always applied	Mostly applied	Sometimes applied	Rarely applied	Never applied
Architects	0	3	4	4	1
Contractors	2	5	8	3	4
Quantity surveyors	4	5	6	6	2
Civil engineers	0	1	0	4	0
Project managers	0	4	5	3	1
Estate surveyor	1	0	0	0	0
Non respondents	0	0	3	0	0

4. Table 4.4.1- 4.4.9 is a breakdown of responses for each demographic group's (professional roles) choice on Drivers to Reuse/Recycling**.** The choices are:

Provision of waste skips, Incentives for waste minimization, technical education to workers, Introduction of selective deconstruction, Increased landfill levy, Increased taxation on natural aggregates, Increased dumping/tipping fines, Increased cost of virgin materials, Formalising scavengers' role.

Table 4.41 Provision of waste skips

	Major Driver	Significant Driver	Minor Driver	Insignificant Driver	Not a Driver
Architects	1	5	3	2	1
Contractors	0	12	7	4	1
Quantity surveyors	5	13	4	1	0
Civil engineers	1	2	2	0	1
Project managers	2	3	5	2	3
Estate surveyor	0	0	1	0	0
Non respondents	0	0	0	0	4

Table 4.42 Incentives for waste minimization

	Major Driver	Significant Driver	Minor Driver	Insignificant Driver	Not a Driver
Architects	2	5	3	2	1
Contractors	4	10	7	2	1
Quantity surveyors	2	10	5	1	0
Civil engineers	2	3	1	0	1
Project managers	1	8	3	1	3
Estate surveyor	1	0	0	0	0
Non respondents	0	2	2	0	4

Table 4.43 Technical education to workers

	Major Driver	Significant Driver	Minor Driver	Insignificant Driver	Not a Driver
Architects	2	4	3	2	0
Contractors	9	9	2	3	0
Quantity surveyors	10	8	2	0	1
Civil engineers	3	2	1	0	0
Project managers	4	5	1	2	0
Estate surveyor	0	1	0	0	0
Non respondents	4	0	0	0	0

Table 4.44 Introduction of selective deconstruction

	Major Driver	Significant Driver	Minor Driver	Insignificant Driver	Not a Driver
Architects	2	4	4	2	0
Contractors	2	16	4	1	1
Quantity surveyors	4	11	6	1	0
Civil engineers	1	2	1	1	0
Project managers	1	3	3	5	0
Estate surveyor	0	0	0	0	1
Non respondents	1	1	2	0	0

Table 4.45 Increased landfill levy

	Major Driver	Significant Driver	Minor Driver	Insignificant Driver	Not a Driver
Architects	0	3	3	4	1
Contractors	4	11	5	1	1
Quantity surveyors	2	6	5	1	7
Civil engineers	0	1	2	2	0
Project managers	2	0	5	3	2
Estate surveyor	0	0	0	1	0
Non respondents	2	2	0	0	0

Table 4.46 Increased taxation on natural aggregates

	Major Driver	Significant Driver	Minor Driver	Insignificant Driver	Not a Driver
Architects	1	1	6	1	3
Contractors	3	5	8	4	1
Quantity surveyors	3	7	5	3	4
Civil engineers	0	2	2	1	1
Project managers	2	4	3	3	1
Estate surveyor	0	0	0	1	0
Non respondents	0	2	2	0	0

Table 4.47 Increased dumping/tipping fines

	Major Driver	Significant Driver	Minor Driver	Insignificant Driver	Not a Driver
Architects	2	3	3	2	1
Contractors	5	10	6	0	0
Quantity surveyors	6	6	6	0	3
Civil engineers	1	1	1	1	1
Project managers	1	3	4	3	0
Estate surveyor	0	0	1	0	0
Non respondents	2	0	2	0	0

Table 4.48 Increased cost of virgin materials

	Major Driver	Significant Driver	Minor Driver	Insignificant Driver	Not a Driver
Architects	4	2	5	1	0
Contractors	4	9	7	2	0
Quantity surveyors	1	8	6	3	4
Civil engineers	1	1	1	2	1
Project managers	1	6	4	2	0
Estate surveyor	0	0	0	0	1
Non respondents	3	1	0	0	0

Table 4.49 Formalizing scavengers' role

	Major Driver	Significant Driver	Minor Driver	Insignificant Driver	Not a Driver
Architects	2	4	5	1	0
Contractors	4	8	7	0	2
Quantity surveyors	1	9	7	1	3
Civil engineers	1	1	1	2	0
Project managers	0	3	3	4	1
Estate surveyor	0	0	0	0	1
Non respondents	1	0	1	2	0

5. Table 4.50 - 4.59 shows breakdown of responses for each demographic group's (professional roles) choice on Barriers to reuse/recycling. The barrier choices are:

Extra cause of reuse, Distance, Availability of recycling facilities, Space to separate/store material, Insufficient regulation to support CDW management, Uncertainty about quality and acceptance of reuse/recycled materials, not adaptable for all waste streams, Organisation of transport to different reclamation sites, Immature recycling market, It is an end of pipe treatment.

Table 4.50 Extra cost of reuse

	Maximum barrier	Significant Barrier	Minimum barrier	Insignificant barrier	No barrier
Architects	1	1	5	2	2
Contractors	1	11	9	2	4
Quantity surveyors	1	11	6	6	0
Civil engineers	1	2	0	2	1
Project managers	1	1	2	8	3
Estate surveyor	0	0	0	0	1
Non respondents	0	0	2	1	1

Table 4.51 Distance

	Maximum barrier	Significant Barrier	Minimum barrier	Insignificant barrier	No barrier
Architects	0	3	3	0	4
Contractors	3	8	6	6	1
Quantity surveyors	3	14	4	2	0
Civil engineers	1	3	1	0	1
Project managers	0	4	2	4	3
Estate surveyor	0	0	1	0	0
Non respondents	0	1	2	0	1

Table 4.52 Availability of recycling facilities

	Maximum barrier	Significant Barrier	Minimum barrier	Insignificant barrier	No barrier
Architects	1	3	3	3	1
Contractors	7	11	4	3	0
Quantity surveyors	10	9	3	0	1
Civil engineers	3	0	0	1	1
Project managers	2	5	2	2	3
Estate surveyor	0	0	0	0	1

Non respondents	1	2	1	0	0

Table 4.53 Space to separate/store material

	Maximum barrier	Significant Barrier	Minimum barrier	Insignificant barrier	No barrier
Architects	2	4	3	2	0
Contractors	2	12	8	0	0
Quantity surveyors	6	10	6	0	1
Civil engineers	1	1	0	3	1
Project managers	0	5	3	2	2
Estate surveyor	0	0	0	0	1
Non respondents	0	3	1	0	0

Table 4.54 Insufficient regulation to support CDW management.

	Maximum barrier	Significant Barrier	Minimum barrier	Insignificant barrier	No barrier
Architects	2	8	2	0	0
Contractors	9	12	2	1	0
Quantity surveyors	11	6	3	3	0
Civil engineers	2	2	0	1	0
Project managers	2	5	3	3	2
Estate surveyor	0	1	2	0	0
Non respondents	0	3	0	0	0

4.55 Uncertainty about quality and acceptance of reuse/recycled materials

	Maximum barrier	Significant Barrier	Minimum barrier	Insignificant barrier	No barrier
Architects	4	4	2	1	0
Contractors	2	15	3	1	0
Quantity surveyors	2	10	6	4	0
Civil engineers	1	1	0	2	1
Project managers	2	6	3	2	1
Estate surveyor	0	0	1	0	0
Non respondents	2	1	1	0	0

4.56 Not adaptable for all waste streams

	Maximum barrier	Significant Barrier	Minimum barrier	Insignificant barrier	No barrier
Architects	2	4	2	3	0
Contractors	0	8	11	1	2
Quantity surveyors	5	4	10	4	0
Civil engineers	0	2	1	2	0
Project managers	1	5	2	3	2
Estate surveyor	0	1	0	0	0
Non respondents	0	0	4	0	0

Table 4.57 Organization of transport to different reclamation sites

	Maximum barrier	Significant Barrier	Minimum barrier	Insignificant barrier	No barrier
Architects	1	4	4	1	0
Contractors	1	13	5	1	1
Quantity surveyors	4	10	5	1	2
Civil engineers	2	2	1	1	0
Project managers	1	2	4	3	2
Estate surveyor	0	1	0	0	0
Non respondents	0	1	3	0	0

Table 4.58 Immature recycling market

	Maximum barrier	Significant Barrier	Minimum barrier	Insignificant barrier	No barrier
Architects	3	5	2	1	0
Contractors	5	11	7	0	0
Quantity surveyors	8	11	4	0	0
Civil engineers	0	3	0	1	1
Project managers	2	4	4	1	0
Estate surveyor	1	0	0	0	0
Non respondents	1	0	3	0	0

Table 4.59 It is an end of pipe treatment.

	Maximum barrier	Significant Barrier	Minimum barrier	Insignificant barrier	No barrier
Architects	1	4	3	3	0
Contractors	0	6	9	3	1
Quantity surveyors	2	2	12	4	0
Civil engineers	0	0	2	2	1
Project managers	0	3	3	3	0
Estate surveyor	0	0	1	0	0
Non respondents	0	0	1	1	0

6. Table 4.60-4.66 Breakdown of responses for each demographic group's (professional roles) choice on Reuse methods. The 7 reuse methods presented to participants are as follows:

Reuse of wood waste as MULCH, reuse of offcuts for general purposes, metal reuse for making tools, excavated soil for landscaping, recycled concrete for production of secondary materials, recycled concrete hardcore for filling of potholes, reclaimed timber for formwork, scaffolding etc.

Table 4.60 Reuse of wood waste as MULCH

	Always practiced	Mostly practiced	Sometimes practiced	Rarely practiced	Never practiced
Architects	1	2	3	3	4
Contractors	3	6	8	7	6
Quantity surveyors	1	4	12	2	3
Civil engineers	1	1	0	3	1
Project managers	4	2	3	3	4
Estate surveyor	0	0	0	1	0
Non respondents	0	0	3	1	0

Table 4.61 Reclaimed timber for formwork, scaffolding, earthwork support (EWS)

	Always practiced	Mostly practiced	Sometimes practiced	Rarely practiced	Never practiced
Architects	3	4	2	1	2
Contractors	6	7	4	3	5

Quantity surveyors	7	4	8	2	2
Civil engineers	3	2	0	1	0
Project managers	4	2	4	2	1
Estate surveyor	0	1	0	0	0
Non respondents	2	0	0	2	0

Table 4.62 Recycled concrete hardcore for filling potholes.

	Always practiced	Mostly practiced	Sometimes practiced	Rarely practiced	Never practiced
Architects	6	2	3	1	1
Contractors	1	14	5	3	1
Quantity surveyors	8	7	4	4	0
Civil engineers	1	3	1	1	0
Project managers	1	7	3	2	0
Estate surveyor	0	1	0	0	0
Non respondents	0	3	0	1	0

Table 4.63 Recycled concrete for production of secondary aggregated for concrete

	Always practiced	Mostly practiced	Sometimes practiced	Rarely practiced	Never practiced
Architects	2	2	2	3	2
Contractors	2	6	10	4	2
Quantity surveyors	1	5	9	2	5
Civil engineers	1	1	0	4	0
Project managers	0	2	5	2	2
Estate surveyor	0	0	1	0	0
Non respondents	0	1	4	0	0

Table 4.64 Excavated soil for landscaping.

	Always practiced	Mostly practiced	Sometimes practiced	Rarely practiced	Never practiced
Architects	4	4	3	1	0
Contractors	7	8	4	4	1
Quantity surveyors	5	8	8	1	1
Civil engineers	4	0	1	1	0
Project managers	8	1	2	1	0

Estate surveyor	0	1	0	0	0
Non respondents	1	2	0	1	0

Table 4.65 Metal for making tools.

	Always practiced	Mostly practiced	Sometimes practiced	Rarely practiced	Never practiced
Architects	2	0	5	4	0
Contractors	3	6	7	5	3
Quantity surveyors	2	4	5	8	3
Civil engineers	1	0	1	2	1
Project managers	1	1	5	3	1
Estate surveyor	0	1	0	0	0
Non respondents	0	0	1	3	0

Table 4.66 Reuse of offcuts for general purposes

	Always practiced	Mostly practiced	Sometimes practiced	Rarely practiced	Never practiced
Architects	2	2	7	2	0
Contractors	5	4	13	1	1
Quantity surveyors	5	4	8	5	1
Civil engineers	2	1	0	2	0
Project managers	1	5	5	0	0
Estate surveyor	0	0	1	0	0
Non respondents	0	0	4	0	0

7. Table 4.67- 4.72 is a breakdown of responses for each demographic group's (professional roles) choice on Factors to enhance CDW management.

The following 6 factors were presented to participants: Provision of technical resources to carry out CDW management, Provision of financial resources to successfully carry out CDW management, Interest of policy makers in matters concerning CDW management**,** Interest of public in matters concerning CDW management, incorporating waste management in the curriculum of tertiary education sectors, Elimination of godfatherism (giving jobs to competent persons instead).

Table 4.67 Provision of technical resources to carry out CDW management.

	Maximum effect	Significant effect	Minimum effect	Insignificant effect	No effect
Architects	3	7	1	2	0
Contractors	8	13	6	2	1
Quantity surveyors	10	12	2	0	0
Civil engineers	1	2	1	1	1
Project managers	4	2	0	5	2
Estate surveyor	1	0	0	0	0
Non respondents	3	0	1	0	0

Table 4.68 Provision of financial resources to successfully carry out CDW management.

	Maximum effect	Significant effect	Minimum effect	Insignificant effect	No effect
Architects	1	8	2	2	0
Contractors	6	15	4	0	1
Quantity surveyors	8	11	3	1	0
Civil engineers	1	2	0	1	1
Project managers	3	4	2	3	1
Estate surveyor	1	0	0	0	0
Non respondents	0	3	1	1	0

Table 4.69 Interest of policy makers in matters concerning CDW management

	Maximum effect	Significant effect	Minimum effect	Insignificant effect	No effect
Architects	4	5	3	1	0
Contractors	8	13	4	0	1
Quantity surveyors	9	14	1	0	0
Civil engineers	2	2	0	1	1
Project managers	1	5	4	3	0
Estate surveyor	1	0	0	0	0
Non respondents	1	3	0	0	0

Table 4.70 Interest of public in matters concerning CDW management

	Maximum effect	Significant effect	Minimum effect	Insignificant effect	No effect
Architects	2	4	6	1	0
Contractors	6	10	5	3	0
Quantity surveyors	8	10	2	3	0
Civil engineers	1	2	0	1	1
Project managers	1	6	4	1	0
Estate surveyor	1	0	0	0	0
Non respondents	0	0	2	0	0

Table 4.71 Incorporating waste management in the curriculum of tertiary education sectors.

	Maximum effect	Significant effect	Minimum effect	Insignificant effect	No effect
Architects	2	7	2	2	0
Contractors	4	15	7	0	0
Quantity surveyors	11	8	5	0	0
Civil engineers	1	3	0	2	0
Project managers	3	6	2	2	0
Estate surveyor	0	1	0	0	0
Non respondents	1	0	1	0	1

Table 4.72 Elimination of godfatherism (giving jobs to competent persons instead)

	Maximum effect	Significant effect	Minimum effect	Insignificant effect	No effect
Architects	4	5	3	5	0
Contractors	8	9	3	9	2
Quantity surveyors	12	8	2	8	0
Civil engineers	2	3	0	3	0
Project managers	5	2	2	2	0
Estate surveyor	0	0	0	1	0
Non respondents	1	0	1	0	0

8. Table 4.73 - 4.79 is a breakdown of responses for each demographic group's (professional roles) choice on Waste management strategies. The 7 waste management strategies are as follows:

Onsite reuse, recycling, energy recovery, landfilling, incineration, informal waste reuse and use of scavengers.

Table 4.73 Reuse (onsite reuse)

	Always used	Mostly used	Sometimes used	Rarely used	Never used
Architects	3	2	4	1	1
Contractors	4	9	7	4	1
Quantity surveyors	2	10	9	3	0
Civil engineers	1	3	0	1	0
Project managers	1	3	3	2	6
Estate surveyor	0	0	1	0	0
Non respondents	1	2	1	1	0

Table 4.74 Recycling

	Always used	Mostly used	Sometimes used	Rarely used	Never used
Architects	2	0	5	4	1
Contractors	1	7	11	4	1
Quantity surveyors	0	6	8	5	4
Civil engineers	0	2	0	1	2
Project managers	1	1	5	3	2
Estate surveyor	0	0	0	0	1
Non respondents	0	2	0	2	0

Table 4.75 Energy recovery

	Always used	Mostly used	Sometimes used	Rarely used	Never used
Architects	0	4	3	2	2
Contractors	0	4	14	1	4
Quantity surveyors	2	6	3	8	5
Civil engineers	0	0	1	4	0
Project managers	3	1	6	2	1
Estate surveyor	0	1	0	0	0
Non respondents	0	0	2	1	1

Table 4.76 Landfilling

	Always used	Mostly used	Sometimes used	Rarely used	Never used
Architects	3	6	3	0	0
Contractors	4	11	6	3	0
Quantity surveyors	4	6	7	4	2
Civil engineers	2	2	0	1	0
Project managers	3	2	2	3	1
Estate surveyor	0	0	1	0	0
Non respondents	0	0	3	1	0

Table 4.77 Incineration

	Always used	Mostly used	Sometimes used	Rarely used	Never used
Architects	1	1	2	4	2
Contractors	2	2	9	7	2
Quantity surveyors	0	4	6	8	5
Civil engineers	0	2	1	1	1
Project managers	1	4	3	2	3
Estate surveyor	0	1	0	0	0
Non respondents	0	0	3	1	0

Table 4.78 Use of scavenger

	Always used	Mostly used	Sometimes used	Rarely used	Never used
Architects	0	2	7	3	0
Contractors	0	4	9	7	3
Quantity surveyors	2	2	12	2	5
Civil engineers	0	3	1	1	0
Project managers	0	3	4	2	1
Estate surveyor	0	0	0	1	0
Non respondents	0	2	3	0	0

Table 4.79 Informal waste disposal

	Always used	Mostly used	Sometimes used	Rarely used	Never used
Architects	1	4	5	0	1
Contractors	0	2	11	4	1
Quantity surveyors	4	3	10	6	1
Civil engineers	0	1	1	1	2
Project managers	2	3	5	2	0
Estate surveyor	0	0	1	0	0
Non respondents	0	3	1	2	0

9. Table 4.80.1- 4.84 is a breakdown of responses for each demographic group's (professional roles) choice on Effect of CDW on the environment.

The following 5 effects were considered: Leachates (poisonous liquid from landfill), Dust, aesthetic problems, loss of natural resources, don't biodegradables (eg plastic)

Table 4.80 Leachates (poisonous liquid from landfill)

	No effect	Insignificant effect	Minor effect	Significant effect	Major effect
Architects	1	2	3	4	2
Contractors	1	3	4	17	4
Quantity surveyors	1	3	2	16	2
Civil engineers	0	4	2	1	3
Project managers	3	4	2	2	3
Estate surveyor	0	0	0	1	0
Non respondents	0	0	2	2	0

Table 4.81 Dust

	No effect	Insignificant effect	Minor effect	Significant effect	Major effect
Architects	1	3	5	3	1
Contractors	1	2	6	2	0
Quantity surveyors	2	1	7	1	7
Civil engineers	1	1	0	1	1
Project managers	0	3	4	3	1
Estate surveyor	0	0	0	1	0

Non respondents	0	0	1	4	0

Table 4.82 Aesthetic problems

	No effect	Insignificant effect	Minor effect	Significant effect	Major effect
Architects	2	3	2	4	2
Contractors	0	4	12	10	0
Quantity surveyors	3	1	3	13	4
Civil engineers	0	1	1	3	1
Project managers	0	6	4	3	0
Estate surveyor	0	0	0	1	0
Non respondents	0	0	2	0	2

Table 4.83 Loss of natural resources

	No effect	Insignificant effect	Minor effect	Significant effect	Major effect
Architects	1	2	3	5	2
Contractors	0	4	6	12	4
Quantity surveyors	2	1	7	12	2
Civil engineers	1	1	0	4	0
Project managers	0	2	3	6	1
Estate surveyor	0	0	0	1	0
Non respondents	0	0	1	3	0

Table 4.84 non biodegradables (e.g., plastic)

	No effect	Insignificant effect	Minor effect	Significant effect	Major effect
Architects	0	0	4	7	1
Contractors	1	4	3	10	4
Quantity surveyors	0	0	7	12	5
Civil engineers	1	1	0	1	3
Project managers	0	1	0	6	5
Estate surveyor	0	0	0	1	0
Non respondents	0	0	1	2	1

10. Table 4.85- 4.89 is a breakdown of responses for each demographic group's (professional roles) choice on effect of CDW on the economy.

The following 5 effects were presented below: Purchase of unused materials, cost of cleaning up CDW in the project sites, cost of cleaning up CDW from the environment, payment for disposal of unused materials, payment for storage and transport of unused materials.

Table 4.85 Purchase of used materials

	Major impact	Significant impact	Minor impact	Insignificant impact	No impact
Architects	3	4	2	3	1
Contractors	4	12	7	4	1
Quantity surveyors	3	10	7	2	0
Civil engineers	2	2	1	1	0
Project managers	0	7	2	3	2
Estate surveyor	0	1	0	0	0
Non respondents	1	3	1	0	0

Table 4.86 Payment for storage and transport unused materials

	Major impact	Significant impact	Minor impact	Insignificant impact	No impact
Architects	1	6	4	2	0
Contractors	3	7	9	6	0
Quantity surveyors	4	12	4	2	0
Civil engineers	3	2	0	1	0
Project managers	0	3	4	4	1
Estate surveyor	0	1	0	0	0
Non respondents	0	2	2	0	0

Table 4.87 Payment for disposal of unused materials

	Major impact	Significant impact	Minor impact	Insignificant impact	No impact
Architects	1	8	3	1	0
Contractors	4	12	4	5	0
Quantity surveyors	4	15	1	2	0
Civil engineers	1	2	1	2	0

Project managers	0	5	2	3	2
Estate surveyor	0	0	0	1	0
Non respondents	2	3	0	0	0

Table 4.88 Cost of cleaning up CDW

	Major impact	Significant impact	Minor impact	Insignificant impact	No impact
Architects	2	7	3	3	0
Contractors	5	7	7	7	0
Quantity surveyors	2	13	5	5	0
Civil engineers	2	2	1	1	0
Project managers	2	4	2	2	1
Estate surveyor	0	1	0	0	0
Non respondents	0	2	2	0	0

Table 4.89 Cost of cleaning up CDW in the project site.

	Major impact	Significant impact	Minor impact	Insignificant impact	No impact
Architects	1	7	1	1	1
Contractors	4	15	4	1	0
Quantity surveyors	0	17	0	2	0
Civil engineers	1	2	1	1	0
Project managers	1	5	1	3	1
Estate surveyor	0	1	0	0	0
Non respondents	0	2	2	0	0

APPENDIX F: REVISED RISK ASSESSMENT FOR PROXY ETHNOGRAPHY

Welsh School of Architecture
Ysgol Pensaernïaeth Cymru

WSA/SHE/RAS/01/1.0

Welsh School of Architecture Risk Assessment

M **Risk Assessment (RA) Title** Remember to complete Footer details	**Risk Assessment (RA) FOR PHD INVESTIGATION IN NIGERIA- INTERVIEW/ETHNOGRAPHY- BY PROXY**	**Date of Risk Assessment**	12/11/20	**Version**	1

Summary of Activity RA Covers
The activity will cover: - interviews on construction and demolition waste reuse and recycling with informal waste workers (conducted in proxy as some of them are illiterates/do not have smart phones/cannot carry out zoom call) - ethnographic study of the business activity of informal waste pickers(scavengers) in their business environment (business premises like waste collection Centre, junk shops, salvage market) – conducted by proxy

RA Assessor(s)		**Person(s) RA Covers**	Support staff (for Chinedu Esther Onyekwere)
Contact Details		**Location(s) RA Covers**	Aba, Nigeria

NOTE: Arrangements must be in place to communicate new and / or revised Risk Assessments to relevant persons. Older versions must be removed from use and filed for future reference/archive.

- **Have you completed the Travel Overseas Form online? (Permission to travel overseas and request cash advance (EXP4))? YES/NO**
- **Have you consulted https://www.gov.uk/foreign-travel-advice for travel advice? Yes**

- *Travel is not permitted to areas where the Foreign and Commonwealth Office advise against travel.*
- *If you choose to ignore the current recommended vaccine and travel health advice for the countries which you are visiting, you will be travelling at your own risk*

Your School/Department Contact

Please enter the number of your emergency contact person in your School/Professional Service here:

Name: Dr Vicki Stevenson

Ext. No.:02920870927

UK embassy in Location

Address: 11 Walter Carrington Crescent, Victoria Island Lagos, Nigeria

Tel: (+234)(1)2770780 to 2

Emergency Number

Please call the Security hotline on **0292 874444** for 24 hour emergency assistance helpline if you need assistance while overseas. (please keep the University informed)

No	What are the Hazards?	Who/ What is at Risk?	Existing Controls	Risk Factor S	Risk Factor L	Risk Factor R	Further Controls	Risk Factor S	Risk Factor L	Risk Factor R	Action By	Action Complete
	Travel –		n/a									
	Travel during trip	support staff	Uber taxi available anytime	4	1	4						
	Accommodation-at destination.	Support staff	Own Accommodation	1	1	1						
	Slips and trips	support staff	Avoid any areas with unsafe terrain. Keep to dedicated pathways, where possible. PPE's (Safety boot with appropriate grip, facemasks, hand gloves, waterproof overalls)	2	2	4						
	Weather/Local Climate including risk of natural disasters	support staff	Dry season, less chances of rain,	***1***	***1***	***1***	Check local weather forecast frequently. water bottles in case of dehydration from sunlight.	1	1	1		

No	What are the Hazards?	Who/ What is at Risk?	Existing Controls	Risk Factor			Further Controls	Risk Factor			Action By	Action Complete
				S	L	R		S	L	R		
	Horseplay	Support staff	Alert to hazards, self-comporting, full attention and concentration to safety procedures, field trip, responsibilities and safety taken seriously	1	2	2						
	Cultural risks/Political risks including Interaction with Local population/Risk of terrorism/ kidnapping/Civil unrest	Support staff	permission from relevant persons sort in advance of the visit/trip, strict adherence to local health and safety rule if any,	4	1	4	Check ed UK Govt. for travel advice	1	1	1		
	Medical emergencies and first aid provisions	Support Staff	Details of local medical emergency procedures to be established before undertaking the research. Researchers or proxies to carry mobile phones with them, in case of an emergency. PPE's worn during field trip, social distancing.	3	1	3						

No	What are the Hazards?	Who/ What is at Risk?	Existing Controls	Risk Factor S	Risk Factor L	Risk Factor R	Further Controls	Risk Factor S	Risk Factor L	Risk Factor R	Action By	Action Complete
	Lost staff or students		Not available									
	Issues due to poor Communication	Support staff	Mobile phones with mobile data	1	1	1	Checked signal coverage, Checked phone is charged at full bar	1	1	1		
	Theft /crime/Security -Including at accommodation and throughout duration of trip	Support staff	Observation in areas with minimal crime and during daytime Own accommodation	1	1	1						
	Hazardous activities during trip including visits to hazardous locations.	Support staff	(support staff visiting hazardous place e.g Landfills has been cancelled). No specific hazards. Wear suitable clothing and PPE's (safety boots, protective gloves, aprons,) conduct observation only in daylight hours	2	2	4						

No	What are the Hazards?	Who/ What is at Risk?	Existing Controls	Risk Factor			Further Controls	Risk Factor			Action By	Action Complete
				S	L	R		S	L	R		
	Local health risks. -Food/drink contamination -Insect/Animal bites	Support staff	Water and food carried along during every outing, PPE (safety boots, gloves, waterproof overalls) worn during every outing against insect/animal bites.	1	1	1						
	Covid 19 Risk	Support staff	Use of PPE's (gloves, face mask, overalls, boots), social distancing at every time, Use of Hand sanitisers, handwashing with soap and water and dry with paper towel,	4	2	8	Check local Covid-19 rate within in area prior to research. Only undertake research if appropriate to do so. Check local government guidance prior to undertaking the research and implement this as appropriate. Ensure that research takes place in well ventilated rooms or outdoors where reasonable possible. Communicate appropriate safety controls to participants.	4	1	4		

No	What are the Hazards?	Who/ What is at Risk?	Existing Controls	Risk Factor			Further Controls	Risk Factor			Action By	Action Complete
				S	L	R		S	L	R		
	Road crossing, road congestion, working on motor way	Support staff	Take special care of traffic at all times Avoid areas of unsafe traffic, stick to pedestrian routes and follow local governmental guidelines in relation to road safety.	2	2	4						

Assessor Signature				Manager Signature		Date	

See WSA Risk Assessment Procedure	**S -SEVERITY L – LIKELIHOOD R – RISK** **RISK FACTOR = SEVERITY X LIKELIHOOD** **REMEMBER: Arrangements must be in place to communicate new and / or revised Risk Assessments requirements to relevant persons.**