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Ethnomimicry: the Development of a Conceptual Model of the Nigerian Practice of the End-of-life Management of Buildings

Ethnomimicry: the Development of a Conceptual Model of the Nigerian Practice of the End-of-life Management of Buildings

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Abstract

The threat of the natural resources exhaustion is pronounced by the unsustainable linear depletion by extraction, production, consumption, and disposal as a waste at the end of service. Realisation of the fact that there is indeed a limit to the carrying capacity of the earth makes it imperative for humanity to retrace its path from the unsustainable practices that destroy the natural environment and threaten the world's stock of natural resources to the more sustainable practices. The built environment is the largest resource consuming human activity and is at the centre of the unsustainable resources depletion trend; which is further demonstrated by the statistics of the enormous amount of construction and demolition wastes produced annually in some economically developed countries of Europe and America. Nonetheless, amongst the preindustrial societies of Nigeria, there is virtually zero demolition wastes. This study is a descriptive investigation that documents the phenomenon of the end-of-life management of buildings in Nigeria and develops a conceptual model that represents the real-life situation of the practices among these native societies.

Furthermore, the paradigm of improving the performance of the construction industry through learning from other sectors, as in the development of the concept of lean construction, was used to explore the feasibility of adopting the best practice models in the end-of-life management of materials from other sectors to improve the Nigerian practices of the end-of-life management of buildings. The best models from the automobile, aviation, ship, cell phone, nuclear industry, and the natural ecological systems were studied and their possible implications on the Nigerian construction industry examined.

A semi-structured interview based on priori themes developed from the best practice models in the different sectors were used for the collection

of data; and template analysis technique was used in the analysis of the data that were interpreted to develop the conceptual model. The conceptual model was validated through two workshops. The participants were selected on purpose based on experience in demolition projects and a predetermined stakeholder groupings quota system; a snow ball technique was used to recruit additional participants.

Inconsistent with the assumption that the construction industry is lagging and should learn from other industries, the findings of this research revealed that the Nigerian construction industry is on par with other sectors by producing virtually zero building demolition wastes. The Nigerian practices of the end-of-life management of buildings were discovered to be largely compliant with the sustainability principles, with few concepts that may be transferred from other sectors.

This thesis proposes that rather than transferring lessons from other sectors, the Nigerian construction industry can be a source of inspiration for developing a sustainable system for the end-of-life management of buildings using the paradigm of ethnomimicry. Ethnomimicry is defined as, *the systematic study of the models of the native societies for inspiration to develop sustainable solutions.*

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Dedications

With gratitude to Almighty Allah the master of the universe, the most Graceful, and the most Merciful, this work is dedicated to my late Grand Mother Zulaihatu Isma'ila whose commitment, love and protection was central to all my achievements in life.

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Abbreviations

ACOPs Approved code of practices

AFRA Aircraft Fleet Recycling Association

AIDS Acquired Immune Deficiency Syndrome

ASR Automobile Shredder Residue

BER Building Emission Rate

BSI British Standards Institution

CDM Construction (Design and Management)

CFC Chloroflourocarbon

CIB Conseil International du Batiment

CRADA Cooperative Research and Development Agreement

DER Dwelling Emission Rate

DFE Design for Environment

DFD Design for Deconstruction

EDA European Demolition Association

EERE Energy Efficiency and Renewable Energy

EIA Environmental Impact Assessment

ELV End of Life Vehicle

EN European Norm

ES Economic Sustainability

EU European Union

GRA Government Reserved Area

GDP Gross Domestic Product

HIV Human Immunodefeciency Syndrome

HSC Health and Safety Commission

HSE Health and Safety Executive

HSWA The Health and Safety at Work etc Act 1974

HVAC Heating, Ventilation, and Air Condition

IAEA International Atomic Energy Agency

IDIS International Dismantling Information System

IMO International Maritime Organisation

IRS Informal Recycling Sector

ISO International Organization for Standardization

ISWA International Solid Waste Association

KNUPDA Kano Urban Planning and Development Authority

LEED Leadership in Energy and Environmental Design

MDG Millennium Development Goals

NEPA National Environmental Policy Act

NFDC National Federation of Demolition Contractors

NIA Nigerian Institute of Architects

NRC Nuclear Regulatory Commission

OEM Original Equipment Manufacturer

OHS Occupational health and safety

OSHA Occupational Safety and Health administration

PAMELA The Process for the Advanced management of End of Life of Aircraft

PDCA Plan-Do-Check-Act

RDF Refused Derived Fuel

REMASAB Refuse Management and Sanitation Board

RoHS Reduction of Hazardous Substances

SSTs Sea Surface Temperatures

SWMP Site Waste Management Plan

TC Technical Committee

UNDP United Nations Development Programme

UV-B Ultraviolet-B

VRP Vehicle Recycling Partnership

WCED World Commission on Environment and Development

WDF Waste Derived Fuel

WEEE Waste Electronic and Electrical Equipment

WHO World Health Organisation

Chapter 1 Introduction

1.1 Introduction

This introductory chapter discusses the motivation, background context, and problem definition for this study. Furthermore, the research aim and objectives, scope of the research are discussed in this chapter.

1.2 Motivation

...*tribal societies do not waste or consume more than they need* (Turteltaub, 1999)

It is reported that in the UK alone, an alarming 90-120 million tonnes of waste is generated from construction and demolition (C&D) annually, comprising of 10% virgin materials that were never used (Osmani, 2012; UK Green Building Council, 2013), despite over 40 regulations on waste (Cabinet Office, 2013). Similarly, in the United States, approximately 140 million tons of construction and demolition waste is reported annually (CDRA, 2016; Kibert, 2005). In another developed country, the Japanese were reported to engage in research to find out ways to recover materials from building demolition for over 25 years without any practicable outcome (Rao, Jha, & Misra, 2007, pp. 72-73).

Whilst this is typical of the economically advanced countries, on the other hand, studies on general waste stream in Nigeria (Nabegu, 2008a; Nabegu, 2008b, 2010), and anecdotal experiences by the researcher, has indicated that there is virtually zero construction and demolition wastes in Nigeria. This stimulates interest considering the importance of resources conservation in the current global wave of sustainability awareness. This ensues the understanding of the Nigerian system of demolition waste management timely and important.

On the other hand, the EU recommended the hierarchical sustainable waste management principle, known as the "waste hierarchy" or "waste pyramid" seems to be compliant with the Nigerian practices. According to the EU waste hierarchy the sustainably most preferable waste management option is to avoid generating waste wherever possible. The next preferable approach is to reuse, thereafter recycle, or energy recovery by incineration, sometimes termed as "waste to energy". The last and least preferable method is dumping the waste in a landfill (see chapter 2). Whilst in economically developed countries, solid waste management in general is inclined towards recycling; in Nigeria, the relatively more sustainable approach of the reuse of materials is more predominant. The concept of the EU waste hierarchy is diagrammatically represented in Fig 1 (DOE, 2012b; Kibert, 2005; McDonough & Braungart, 2009; Nowak, Steiner, & Wiegel, 2009).

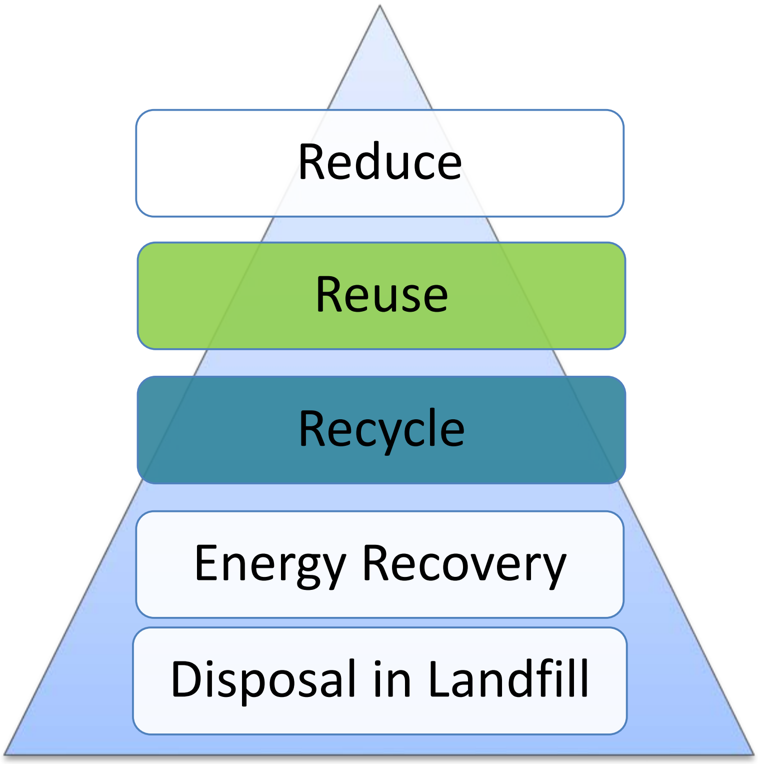


Figure 1: Waste Pyramid Showing relative position of Nigeria

According to the Cabinet Office (2013) website, there may be up to forty regulations in the UK relating to waste management *(see Appendix 1.0: Waste Related Legislations in the UK)*, with some construction and demolition sector specific legislations such as *Aggregates Levy* and *Site Waste Management Plan Regulation 2008 (SWMP),* intended to make businesses responsible for collecting, treating, and recycling products (Cabinet Office, 2013). On the other hand, in Nigeria there are some legislations on waste in general, however, there is dearth of legislations that are specific to construction sector except few general environmental laws that capture waste but with few regulatory guidance and control (Environmental Law Institute, 2013).

Additionally, whilst stakeholders in the Nigerian construction industry may not be familiar with the terms construction or demolition wastes, there is yet no evidence to suggest that the UK Waste Framework Directive target of recovering 70% of C&D waste by the year 2020 will be achieved through the legislative initiatives (DEFRA, 2011). The announcement by DEFRA for the removal of the SWMP (2008) with effect from December, 2013 casts more doubts to the efficacy of the legislations (Eminton, Quinault, Date, & North, 2012). There is similarly a call to the public to suggest whether the legislations should be scrapped altogether, reformed, simplified or merged. The possibility of achieving the purpose of the regulations through non-legislative alternatives and more effective implementation strategy are as well being considered as another option (Cabinet Office, 2013).

A preliminary reconnaissance and accounts of personal experiences of practitioners suggest that what may be termed as C&D waste in the UK or elsewhere is considered as merchandise in Nigeria. There is a specialised market for the otherwise "waste" products, ranging from the by-product of the construction processes, damaged or non-use, excess, salvaged items, and demolition rubbles. In many instances, the challenge is in the management of the competition for the control of the much-sought "re-useable items". Even though this tendency is not limited to Nigeria; as reported by Boyle (2014), there were instances of serious competition for the otherwise unwanted items from a decommissioned building in the UK for example. A story of chaos over competition to acquire the contents of a disused building that the police had to intervene was published in the media (Boyle, 2014). In some Nigerian institutions, there was a report of established structure for auction of such items to the public. In extreme cases, there were cases of hold-ups and complaints of frauds associated with such processes (Dantata, 2008).

There are several stakeholders involved in the operations of the salvage market, and can be classified into different groups (see section 4.7.2). The specialist stakeholders are the actors that make a living out of the materials salvage as a profession. Derived by the socio-economic factors, with barely any regulation, design, or intervention, these various stakeholders have established an industry that forms an "organic industrial ecology" that virtually eliminates demolition waste from the stream of wastes in Nigerian landfills. Industrial ecology sometimes referred to as "industrial symbiosis" is fashioned after the natural ecology whereby the by-product of one process is used as a raw material for another process (Kibert, Sendzimir, & Guy, 2000).

While there are examples in history of preindustrial societies that collapsed from unsustainable practices, such as the Eastern Islanders (Diamond, 2005), the Nigerian practices of end-of-life management of buildings is one of the good examples of sustainable practices among native societies as was reported in the case of the ancient Japanese that managed to live sustainably over time. It was reported that ancient societies such as Easter Island, Pitcairn Island, Henderson Island, and the Classic lowland Maya collapsed due to environmental disasters they failed to manage; whilst on the other hand, there are ancient societies such as

Tikopia and Japan that survived for thousands of years by successfully developing sustainable practices in environmental management (Diamond, 2005). The Nigerian practice of the end-of-life management of buildings can be considered belong to the latter group “that do not waste or consume more than they need” (Turteltaub, 1999).

The motivation for this study is inspired by the observation of this phenomenon and the need for a systematic investigation into the practices for improved understanding of this sustainable system. The systematic study of the sustainable practices of the tribal societies is hereby referred to as “ethnomimicry”.

1.3 Background Context: Sustainability and the Built Environment

Family leaflet and website of the London Museum claims that its collection starts from a time when animals roamed Trafalgar Square through to the issues of the 21st century (Museum of London, 2013). This claim stimulates such questions as, "where are animals? …what happened to their homes (habitat) and the sources of their food?" This is a typical example of the extents of destructions built environment can do to natural environment and ecology (Belogolovsky, 2009; Brown, 2001; Mark, 2000). Aaron Betsky cited by Belogolovsky (2009), described the idea of man-made structures with limited sunlight, restricted air and views substituting the once open land with abundance of sunlight and fresh air in a perfect harmony with skyline as the *"architecture's original sin".*

Nonetheless, as noted by Hawkes (2011), the aggravation of unsustainable architecture tallies with the period of the industrial revolution. This is further corroborated by the description of the original English architecture by HRH Charles the Prince of Wales, as built by what came closest to hand (Inäcio, 1999). The existing status quo for several centuries was nevertheless, spontaneously changed by the mechanical services that were introduced into buildings. The buildings adapted to the natural environment were replaced with those that rely on the supply of unsustainable energy generated with imported fossil fuel (Banham, 1969; Hawkes, 2011).

The Machine Age started with strong oppositions from inception due to its perceived vices (Farmer & Richardson, 1999; Farmer et al., 1996; The National Archives, 2013), until it became one of the man's major issue of the 21st century (RIBA, 2009a, 2009b, 2009c, 2009d).

Thanks to the inquisitive scientific world that discovered and awakened humanity to the fact that the unsustainable damage to the natural environment and consumption of the “perceived unlimited” natural resources cannot continue indefinitely. Humanity will have no option but to switch away from the unsustainable exploitation of nature beyond its capacity through conscientious effort, or forced by natural consequences (Meadows, Meadows, Randers, & Behrens, 1972). Humanity was further alerted that, it is not only the carrying capacity of the earth that is being stretched beyond limits, the resultant pollutions may be capable of leading to extinction of the human race (Mark, 2000), this is however not a prediction of the end of the world at any particular time. Nevertheless, it implies that unsustainable development that is not commensurate with the capacity of the natural resources must stop whatsoever (Randers, 2012).

Development as defined by Todaro and Smith (2011) is *“the process of improving the quality of all human lives and capabilities by raising people’s levels of living, self-esteem, and freedom”.* It was nevertheless accepted as a global agenda to pursue development for the satisfaction of the current generation without jeopardising the feasibility of the same privilege for the future generations (Brandon & Lombardi, 2011; Brundtland, 1987; Goodland & Daly, 1996). This is the new idea termed “sustainability” with three facets: environmental, economic, and social (Grants, 2006; Shell Livewire UK, 2013). Global warming and resources consumption are surely among the most critical issues in the sustainability quest (Hueting & Reijnders, 1998; Shah, 2011); therefore, making the built environment one of the centres of focus being a large contributor to the two (Kibert, 2005).

The contribution of buildings to global warming spans from the embodied “energy” consumed in the manufacturing of the building materials through to the stages of construction, operation, and demolition (Berge, 2009). Whilst being responsible for 70% of the energy consumption (Brandon & Lombardi, 2011), nearly half of the estimated 560 Million UK carbon emission (RIBA, 2009b, 2009c, 2009d), and 30% of the global emission is from buildings alone (Belogolovsky, 2009). The impacts of buildings are not only limited to energy consumption and carbon emission, but also 40% of the global acid rains (Belogolovsky, 2009), natural ecology, water, land, and solid waste (Kibert, 2005).

On the other hand, the US estimate suggesting that 90% of all materials ever extracted may be residing in the built environment (Kibert, 2005; Kibert, 2002), calls for attention if sustainable resources consumption is to be achieved. The question of *"how much does your building weigh"* associated to Buckminster Fuller (1974) (Fuller, 2002; Kibert, 2005), becomes even more relevant now as a challenge to architects to be conscious of the materials used in buildings. Furthermore, many of these materials are returned to the earth as wastes with the added environmental pollution, and occupation of open spaces. In the UK alone, an alarming figure of annual 90-120 million tonnes of waste are associated to construction and demolition (C&D), with more than 10% of unused materials as disclosed by Government sources (Osmani, 2012; UK Green Building Council, 2013).

Subsequently, a solution to the waste generated from demolition of buildings at the end of its usefulness will ameliorate one of the major sustainability challenges facing humanity: depletion of resources. One of the approaches to achieve this objective is learning from other sectors.

The desirability of construction learning from other sectors is an old age discussion contained in the report of Latham (1994), Egan (1998) and others as cited by Keraminiyage (2009, p. 3) and Lee (2002, p. 25) for example. Egan (1998) was cited to remark:

"We see that construction has two choices: ignore all this in the belief that construction is so unique that there are no lessons to be learned; or seek improvement through re-engineering construction, learning as much as possible from those who have done it elsewhere" (Egan, 1998).

In line with this thinking, it was considered desirable for this study to explore the sustainable practices for the end-of-life management of materials in different sectors with the aim of discovering sustainable practices that may be transferrable to improve the practices in the Nigerian construction industry. Subsequently, best practice models for the end-of-life management of materials in the automobile, aviation and ship industries were explored in chapter 3. Other sectors studied for the best sustainable practices in the end-of-life management of materials include the cell phone, nuclear, and natural ecological system.

The research methodology for the investigation into the Nigerian practice of the end-of-life management of buildings will be discussed in chapter 4, while the analysis and findings will be discussed in chapter 5.

In chapter 6, a conceptual model of the Nigerian practice of the end-of-life management of buildings was developed and validated in chapter 7. In chapter 8, the new concept of ethnomimicry was discussed in relation to the Nigerian practices of the end-of-life management of buildings. The concept of *"ethnomimicry"* is introduced as a systematic study of the systems of the tribal societies as a source for inspiration for developing sustainable solutions.

1.4 Problem Definition.

The thought of minimising the negative impacts of buildings on the environment started to resonate among many thinkers of the twentieth century, and new approaches that sought to provide a more sustainable solution than the conventional methods of building begin as ecological designs, green buildings, ecologically sustainable designs and high performance buildings (Kibert, 2005). Consequently, if buildings are to be sustainable, the pressure of resources consumption should be in the forefront (RIBA, 2009b, 2009c, 2009d). It is therefore imperative not only to devise an appropriate response in the way we erect and operate buildings, but also how to eliminate the waste generated by building construction in general and demolition in particular.

According to one of the influential sustainability thinkers, Benyus (1997, p. 1), it is now an extraordinary time that the search for sustainable solutions may include learning from the wisdoms of the preindustrial societies for inspirations on how to live in harmony and sustainably on earth. The enormous amount of wastes generated from the demolition of buildings demand a solution, which may include learning from the practices of the native societies. The undocumented Nigerian practice of the end-of-life management of buildings, which generates zero demolition wastes is considered eligible for a systematic inquiry for documentation and improved understanding of the most probable influencing variables.

On the other hand, while construction is considered unique “conglomerate of industries” characterized by many inadequacies and paradoxes, and not comparable to other sectors (Koskela, 2000), there are evaluations of construction in comparison to manufacturing industry under different themes (Koskela, 2000; Solís, 2009). The work of Koskela (2000) on construction production theory akin to manufacturing and the development of lean construction are some of such efforts; nevertheless, there has been no commensurate efforts to improve the end-of-life management of buildings by learning from the manufacturing or other sectors.

In this study, whilst the description of the Nigerian practices of the end-of-life management of buildings is investigated, the best practice models in different sectors were explored to possibly learn lessons for the improvement of the practices in the construction industry within the Nigerian context.

1.5 Original Contribution.

The contributions of this research to knowledge and practice are enumerated below:

- A comparative analysis of the construction industry with other industries specifically automobile, aviation, ship, cell phone, and nuclear sectors in terms of sustainable practices in the end-of-life management of materials.

- Increased understanding and the first documentation of the Nigerian practice of the end-of-life management of buildings, and its relevance to the sustainability principles.

- Identified the potentials and shortcomings of the Nigerian practices of the end-of-life management of buildings and proposed improvements.

- Development of a conceptual model that represents and simplifies the understanding of the real-life situation of the practice of the end-of-life management of buildings in Nigeria.

- Introduction of the idea of “ethnomimicry” whereby the traditions of the pre-industrial societies are viewed as possible sources of inspirations and lessons on sustainable lifestyle.

1.6 Aim and Objectives of the Research.

The Research aim:

The aim of this research is to develop a conceptual ethnomimicry model that represents the Nigerian practice of the end-of-life management of buildings.

Objectives:

The objectives of this study are:

- To gain a theoretical knowledge and understanding of the position of construction and material waste in the sustainability agenda in general, and construction demolition waste in particular.

- To explore best sustainable practice models of the end-of-life management of materials in different sectors.

- To formulate a methodology for investigating the practice of the end-of-life management of buildings in Nigeria.

- To investigate the implications of sustainability and best practice models on the Nigerian practice of the end-of-life management of buildings.

- To develop and validate a conceptual model of the Nigerian practice of the end-of-life management of buildings.

The procedures for achieving the aim and objectives are illustrated in the following diagram and discussed in details in the methodology chapter.

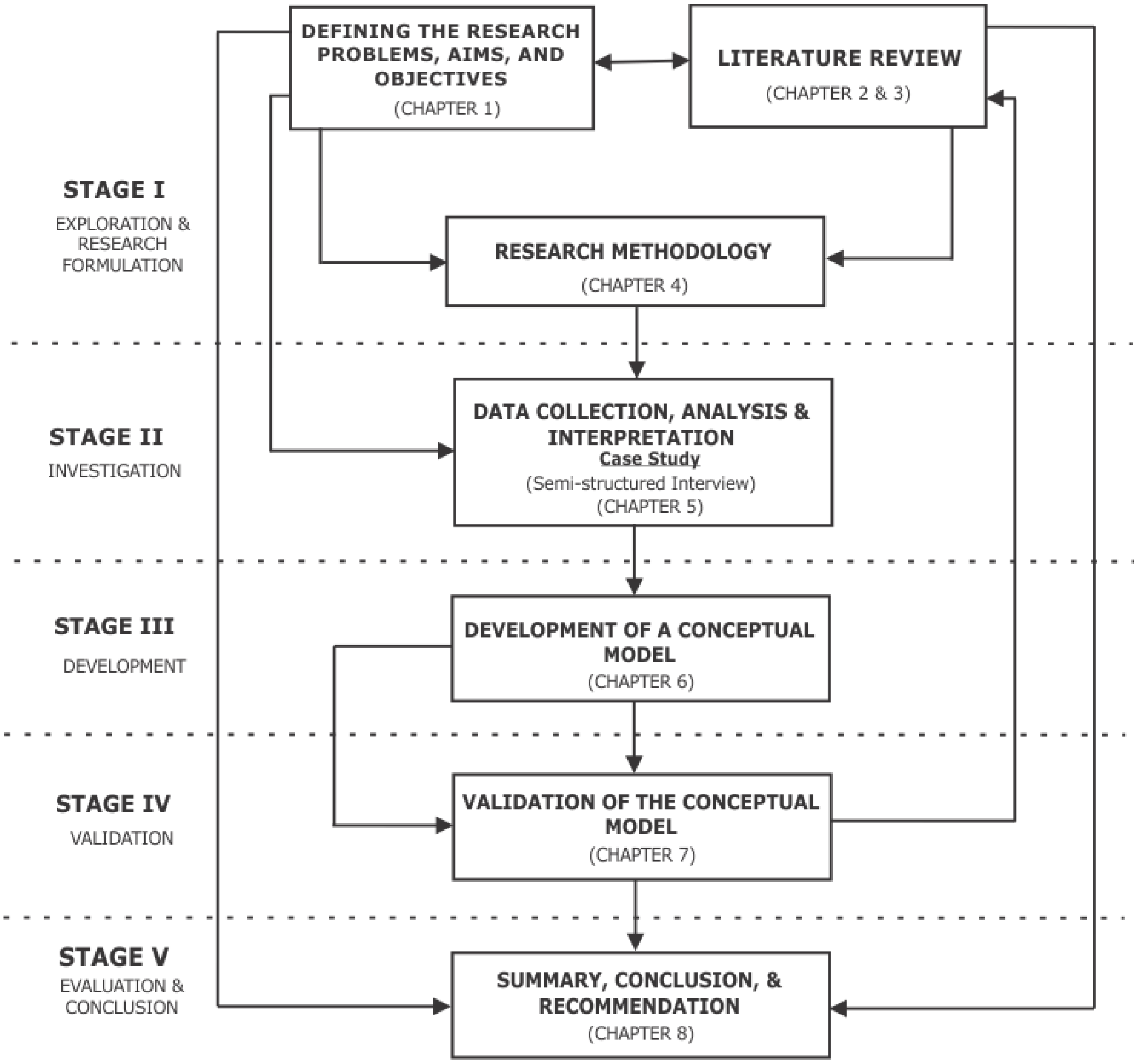


Figure 2: Research Design Process

1.7 Scope.

The scope of this study is limited to the subject of sustainability as opposed to other themes that may be used to view the phenomenon of this investigation such as the political economy or sociology. This is due to the importance of the sustainability and relevance the discipline of this study.

It is common in literature and practice to consider construction and demolition wastes under the same category of waste, nevertheless, this study is limited to the building demolition wastes. This is to the exclusion of other forms of construction and demolition wastes such as bridges, roads, dams, and other man-made structures. This is because, in addition to the relevance to the discipline of this study, buildings are probably the most common structures that produce the salvaged materials that trigger this study.

The scope of this research is limited to buildings belonging to use groups F (institutional), H (residential) and J (mixed use and occupancy) according to the Nigerian National Building Code classification. The data collected only covers conventional buildings typical all over Nigeria predominantly constructed from cement products, steel, stone, aluminium, timber and ceramic materials.

1.8 Summary and Link

This study is motivated by a phenomenon in a semi-industrialised society whereby zero waste is produced from building demolition activities. The third party enterprises that handle the materials from building demolition form an industry comprising of different stakeholders that interact and play different roles in the end-of-life management of decommissioned buildings. The purpose of this study is to develop a conceptual model of this phenomenon after establishing its conformity with the sustainability concept.

In order to achieve this aim, Chapter 2 discusses the relationship of the built environment and demolition waste to the sustainability paradigm, while Chapter 3 explores the best practices of end-of-life management of materials in different sectors as a benchmark for gauging the merits of the phenomenon of this study. Chapter 4 formulates the methodology that guides the research undertaking. Chapter 5 discusses the data collection, analysis, findings and interpretations. Chapter 6 on the other hand describes the development of a conceptual model for the practice of the end-of-life management of buildings in Nigeria. Chapter 7 contains descriptions of the validation of the conceptual model through workshops. Chapter 8 is the summary, conclusion, and recommendations of this research.

Chapter 2 Building Demolition waste, the Built Environment and Sustainability.

"Climate change brought about by man-made emissions of greenhouse gases has been identified as the greatest challenge facing human society at the beginning of the twenty-first century" (RIBA, 2009a, 2009b, 2009c, 2009d)

2.1 Introduction to the Concept of Sustainability

In economic terms, *"the sustainability concept is as defined in 1946 by economist Sir John Hicks being the amount one can consume within a period while maintaining the same status at the end of the period"* (Goodland & Daly, 1996). While in environmental terms, *sustainability* on the global scale refers to the perpetual existence of humankind within the natural systems without offsetting the balance that is needed for continuity of life (Diesendorf, 2000).

The term sustainability is sometimes used interchangeably with the phrase "sustainable development" which can otherwise be defined as:

i. "Development that is likely to achieve lasting satisfaction of human needs and improvement of the quality of life" (Allen 1997: 23 in (Inäcio;, 1999).

ii. "A pattern of social and structural economic transformations (i.e. "development") which optimises the economic and social benefits available in the present, without jeopardising the likely potential for similar benefits in future (Goodland and Ledoc 1987 in (Inäcio;, 1999).

iii. “*Development without growth in throughput of matter and energy beyond regenerative and absorptive capacities”.* (Goodland & Daly, 1996)

Despite being described as a vague terminology (Brandon & Lombardi, 2011), sustainability is now a household name with very wide applications and acceptability that it is sometimes described as the man’s major issue of the 21st century (RIBA, 2009a, 2009b, 2009c, 2009d). Conferences and summits were organised at various levels, sometimes with over hundred world leaders to discuss issues centred around the issue of sustainability and sustainable development (Brandon & Lombardi, 2011). This suggests that the issue of sustainability is so critical to the humanity in general as discussed in the next section.

2.1.2 Why Sustainability

The influential report for the Club of Rome is a milestone in awakening humanity to the fact that the unsustainable exploitation of the natural resources including consumption of the “perceived unlimited” natural resources cannot continue. Humans will have no option but to switch away from the unsustainable exploitation of nature beyond its capacity through conscientious effort, or forced to adjust by natural consequences (Meadows et al., 1972). This was not a prophesy for the end of the world at any particular time, nevertheless, it implies that unsustainable development that is not commensurate with the capacity of the natural resources must stop whatsoever; either by man or by nature (Randers, 2012).

There were alternative views such as the retracted Gaia theory, which argued that organisms, including humans, interact with the environment in a naturally self-regulating manner that ensures continued survival of species (Bormann, 1981; Environment, 2013). Nevertheless, overwhelming scientific evidences such as the Biosphere 2 experiment dispel such views; the many negative consequences of human activities suggested that there is indeed a limit to growth, there is a limit to the carrying capacity of the earth (Biospherics, 2013; Cohen & Tilman, 1996; Rogers, 2011).

Emissions of carbon dioxide, methane, nitrogen oxide, and CFC gasses from human activities change the atmospheric chemical composition and trigger some processes that are inimical to environmental sustainability (Norgard & Christensen, 1994). The combined impacts of these gasses on the environment are greenhouse effect, destruction of ozone layer, and global warming due to increase in the ultraviolet-B (UVB) radiation getting to the earth's surface, which are the causes of the climate change (Brown, Flavin, & French, 2000; Goodland & Daly, 1996).

Deforestation is another phenomenon that contributes to the destruction of the earth life support systems. The destruction of the natural vegetation generates a chain of damages that extends beyond the intended area, but also distorts the rainfall pattern and the biomass and thousands of species of creatures whose habitat has been destroyed as well as contributes to offset the global CO_2 balance and increases the global warming (Brown et al., 2000).

The sustainability of the world's fresh water supply is threatened by the extraction of underground water for agricultural, domestic, and industrial purposes at a rate that is higher than the rate of replacement by precipitation (Brown et al., 2000). The story is the same with fishery and the other biodiversity with an estimated 11% of all birds' species and 25% of all mammals classified as endangered (Brown et al., 2000).

The mineral resources supporting several global economic activities may arguably limit global economic development. Nevertheless, Gelb, Kaiser, and Viñuela (2012) believe that other ecological limitations such as climate change and water are more likely to constrain what they term resource-based development than resources deficit (see section 2.3 for further discussion).

Additional evidence to the possible catastrophic consequences of ecological damage to human survival was demonstrated in a number of historical societies that collapsed from the unsustainable exploitation of the environment or “ecocide” among other factors. Example of such societies include the Maya cities in Central America, the Great Zimbabwe in Africa, Mycenaean Greece in Europe, and the Easter Island in the Pacific Ocean (Diamond, 2005). The present societies face the same environmental problems as the past societies, with additional challenges. According to Diamond (2005), the eight environmental challenges similarly faced by the past societies can be categorised into deforestation, soil, water, overhunting, overfishing, species, population, and increased human impact per capita. Nevertheless, four other threats that have not been found in past societies are human induced climate change, toxic chemicals in the environment, energy shortages, and exhaustion of the photosynthetic capacity of the earth (Diamond, 2005, pp. 15-16).

The latter four threats are the consequences of the introduction of the machinery and development of the industry driven by fossil fuel consumption and rapid natural resources extraction with consequential degradation of the natural environment and new social phenomena such as population increase and urbanisation, consumerism and solid waste generation, and new order for social stratification in the society (Chappine, 2015). On the other hand, human activities are responsible for improved quality of life. This points to the need for reconciling the conflicting attributes of development.

2.1.3 Sustainable Development

The term sustainability and sustainable development are sometimes used interchangeably; however, Brandon and Lombardi (2011) opined that despite its wide acceptance, the term sustainability is still considered by many as vague. Sustainable development seems rather more meaningful considering the root terms: *sustain* and *develop* that implies "facilitating improvement without jeopardizing what already exists".

The most commonly cited definition of sustainable development is that of the report of the World Commission on Environment and Development popularly known as the Brundtland's Commission as: *"the development that satisfies the needs of the present generation without compromising the ability of the future generations to meet their needs"* (Brundtland, 1987).

Brundtand's definition, despite its acceptability, is sometimes criticised for lack of any precision (Thomas & Adams, 1997). The definition centred about equity and futurity but it is argued that the futurity and equity assumptions in the definition were not qualified. In addition to time, another of such imprecisions of the definitions is in the dimension of space. Some other authors accuse the definition for its lack of distinction between needs and wants as well as economic growth and development. Another deficiency of the definition is the absence of a mention of *"natural environment"* despite its significance while giving emphasis to *"human needs"* (Diesendorf, 2000). Nevertheless, the definition encapsulates the underlying concept of sustainability by its emphasis on futurity and development.

Development on the other hand is considered as yet another vague term requiring clarification, however, its objectives target the reduction of poverty, illiteracy, diseases and hunger (Goodland & Daly, 1996). Todaro and Smith (2011) nevertheless, defined development as *"the process of improving the quality of all human lives and capabilities by raising people's levels of living, self-esteem, and freedom."* According to this school of thought, there are *three core values and three objectives of development*. The core values were identified as sustenance, self-esteem and freedom while the objectives were identified as equitable distribution of resources, improved standard of living and socio-economic freedom (Todaro & Smith, 2011). Sustainable development is distinguishable by serving the present in a manner not to jeopardise the opportunities for the future generations as contained in the Brundtland's definition, or what Diesendorf (2000) describes as inter and intra generational equity.

Improved standard of living requires economic growth, however, the call for 5-10 fold increase in economic growth in the Brundtland's report is perceived to be in support of a toxic economic growth in the use of materials and energy at the expense of the natural environment (Diesendorf, 2000; Goodland, 1995). When the WCED reconvened in 1992 this call was abandoned, despite being the basis for the outcome of the Rio Earth Summit held in 1992 in Brazil (Brandon & Lombardi, 2011). This suggests that in sustainability thinking, however much economic growth may be necessary, must not compromise the integrity of the physical environment.

On the other hand, the integrity of the physical environment cannot be secured without eliminating poverty, as was communicated in the words of the WCED when it stated: *"Those who are poor and hungry will often destroy their immediate environment in order to survive: they will cut down forests; their livestock will overgraze grasslands; they overuse marginal land; and in growing numbers they will crowed into congested cities" (Agenda, 1992; Brundtland, 1987; Goodland & Daly, 1993; Moseley, 2001).*

This points to the intricate relationship between economic and technological growth, poverty and general social wellbeing, and the physical environment (Goodland & Daly, 1996). These form the basis for the three types or elements of sustainability: economic, social, and environmental sustainability.

2.1.4 Economic Sustainability

Despite liquidation of the natural capital by the global economy, the majority of the people of the world are living within subsistence level. As observed by Shah (2011), consumption became even more critical if the pattern of distribution is put into consideration. Statistics of the UNDP (1998) human development report indicated that, while the world's poorest 20% consume only a paltry 1.3% of the resources the upper 20% of the world's population in the rich countries are responsible for 86% of the world's consumption. The relative per capita consumption of energy in the developing countries ranges from 13 to 280 times less than that of the United States (Ehrlich & Ehrlich, 1989; Goodland & Daly, 1996). The redistribution of wealth to uplift the poorest is a subject of another discourse; however, the current consumption pattern is not on the sustainable path.

Sustainability can simply mean extraction of goods and services from natural capital without exhausting it while the definition of natural capital is the reserves of the ecologically abundant assets such as soil, atmosphere, forests, water among others, that can be utilised by humans (Goodland & Daly, 1996; Pimentel et al., 1992). Using the economic terms of capital as defined in 1946 by Hicks, consumption of natural capital is therefore not income but liquidation of capital as against capital accumulation. While in the past the natural capital is not taken into consideration in many economic activities due to their abundance, it has now become the major constraint to many economic activities (Goodland & Daly, 1996).

Generally, the natural capital can be classified as renewable or non-renewable resources. Renewables are resources that are replaceable or can be used inexhaustibly such as the sunlight. The non-renewables by inference refer to the natural resources that are not replaceable. There is another category of capital resources called "Cultivated Natural Capital" such as pond-bred fish, plantation forest or cattle herd that are replenished artificially (Berge, 2009; Farlex inc., 2013).

Economic sustainability will therefore require management of renewable resources for the long term; reduce waste and pollution, use energy and materials efficiently and economically. Then invest in repairing the damage already done to the planet through extraction of resources and creating the enabling socio-political environment suitable for sustainability. The input and output rules are good recommendation for the assessment of the sustainability of any particular project.

The input rule is approached in two ways: renewables and non-renewables. The renewables should be used at the same rate with the regeneration by the natural system. While the use of the non-renewables should not exceed the rate that substitutes are being developed through research. Such research should be funded from the proceeds of the use of the non-renewables. While in the output rule the waste generated by every project should not exceed the capacity of the immediate environment to absorb without compromising the ability to do so in the future (Dasgupta & Heal, 1979; El Serafy, 1991, 1993; Goodland & Daly, 1996).

ES can also be graded as weak, intermediate, strong or absurdly strong depending on the reconciliation of the four types of capital i.e. the natural, manufactured, social and human capital. Weak sustainability is a situation whereby the level of capital is maintained irrespective of its composition from the four types of capital. This implies that any of the capitals is a perfect substitute for the other, a situation that cannot be sustainable. While intermediate sustainability is a model whereby there is a deliberate intention to maintain the level of each of the types of capital within a critical level, though such critical level may be unspecified. Strong sustainability is, on the other hand, a sustainability model whereby each of the types of capitals is maintained intact independently for availability to future generations. And absurdly strong sustainability is a situation whereby non-renewable resources are not used completely while the renewable resources are used at the same rate they are reproduced (Hueting & Reijnders, 1998).

Another approach to achieve sustainability is adopting the source and sink concepts which adopts the economic definition of sustainability as "non-declining wealth per capita". In this model production and consumption should be equal whereby production is the maintenance cost of the stock and should be minimised (Hueting & Reijnders, 1998).

The reliance of the economy and the society on the functioning and providence of the natural systems justify the emphasis on the environmental sustainability. The danger associated with any form of damage to the natural life support systems qualifies the environmental aspect as a moderator to any socio-economic development (Diesendorf, 2000). The relationship of the economic system to the global environment is as illustrated diagrammatically below (figure 3, 4 and 5) adopted from Tietenberg (2007) and Goodland and Daly (1996).

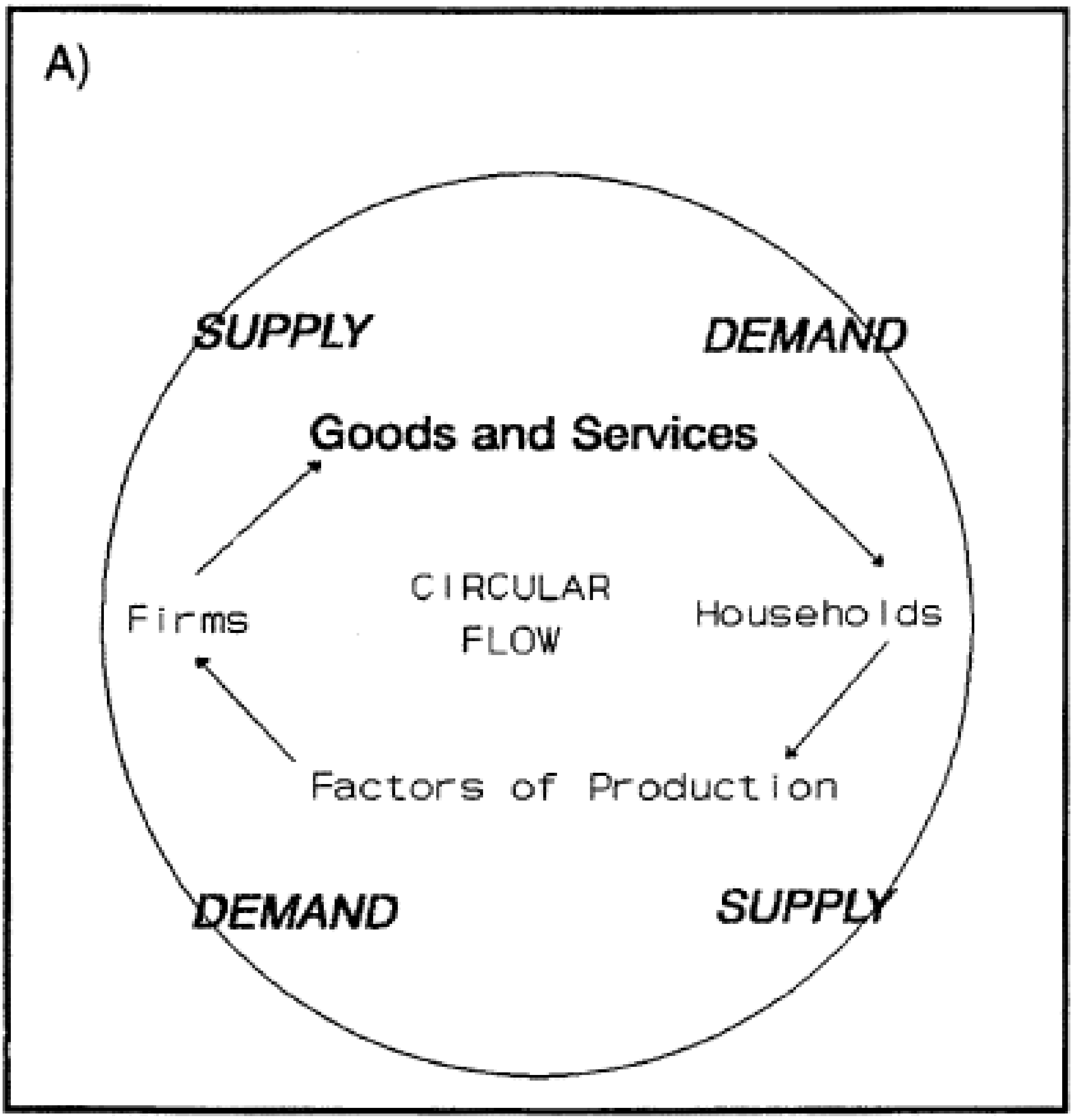


Figure 3: Economic System as an isolated system

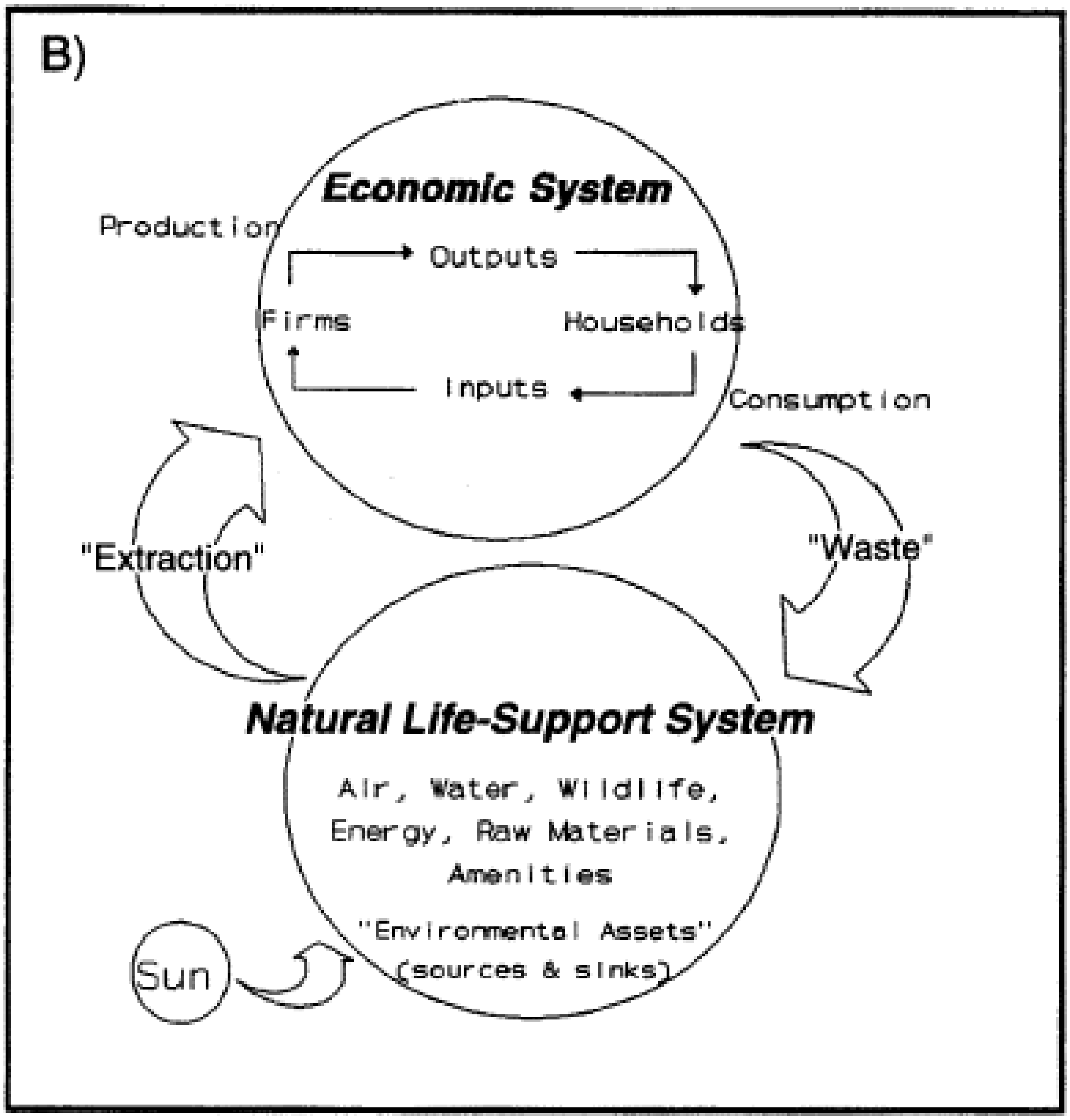


Figure 4: Relationship of economic system with the environment

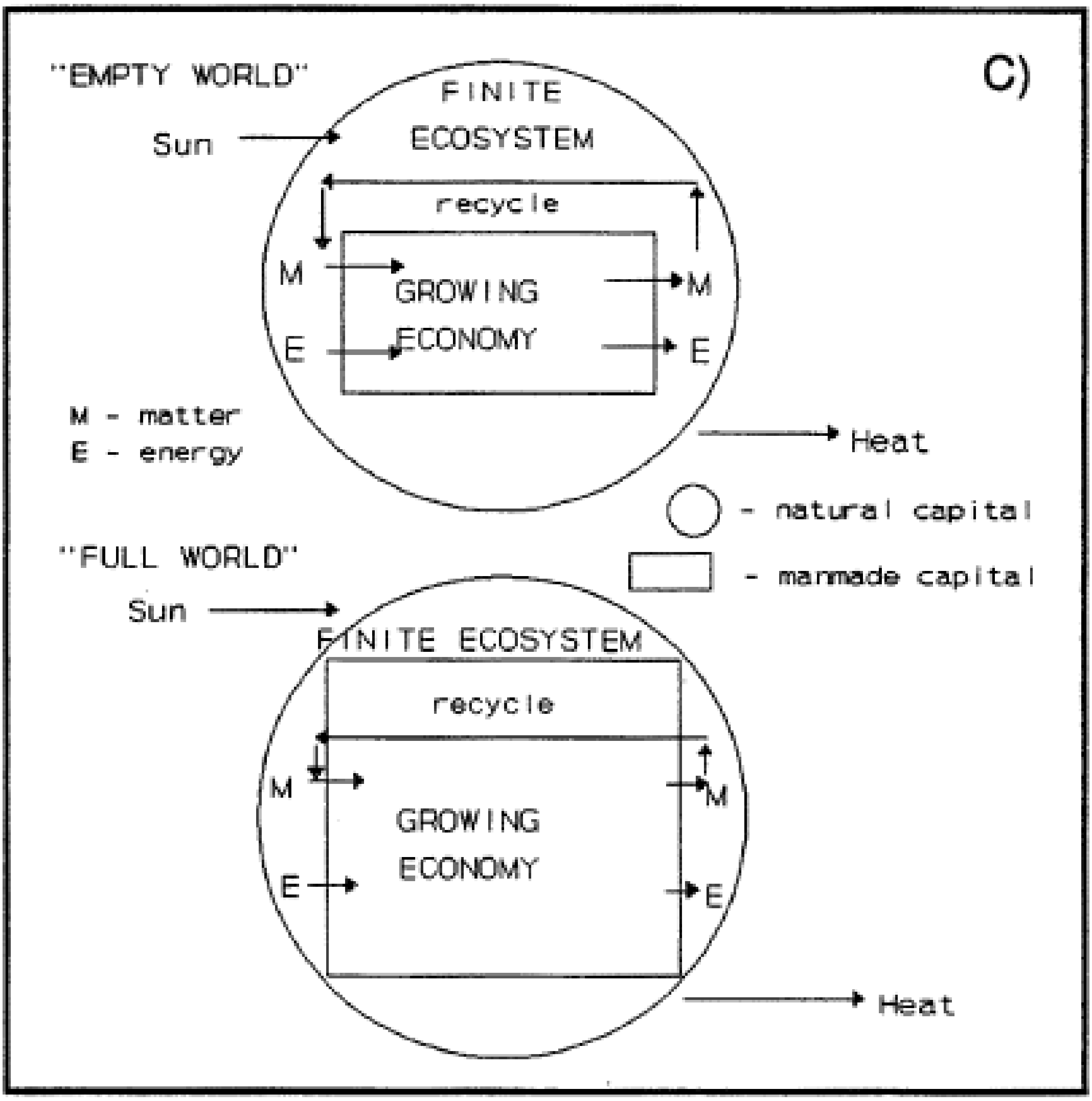


Figure 5: Economy as dependent on the environment (Adopted from Tietenberg 1992)

When economic activities are considered in isolation, (Fig3) shows the circular flow between supply and demand, production and consumption, the relationship of economic activity and environmental sustainability can be expressed by multiplying the two variables of population and per capita consumption of natural resources. This will give a total throughput flow of resources from the global ecosystem to the economic subsystem and can be rated as large or small in relation to the fixed global ecosystem. The resources are in turn returned to the global ecosystem as wastes (Fig 4). The economic subsystem grows while the global ecosystem remains fixed, until the former started to interfere with the processes of the latter (Fig 5), (Goodland & Daly, 1996).

Sustained yield is sometimes confused with ES, even though related, however the former is usually an optimal solution for a single variable such as the sustained yield of fish from sea, but sustainability is concerned with the more complex interrelationship of various variables within a system or sub-system.

While discussing the production, distribution and consumption of goods and services may be described under economic pillar of sustainability (The American Heritage, 2013), the biophysical issues such as the greenhouse effect, global warming, ozone layer depletion, biodiversity, water, soil, etc. should be discussed under the environmental sustainability.

2.1.5 Environmental Sustainability

Air, soil, biodiversity, water, and minerals are the five 1974 *Huetingian* direct or indirect environmental functions that can be obtained from our biophysical ecosystem. According to this paradigm, we are at risk of bankruptcy if any of these is threatened until we are able to find a substitute. Sustainability is thus viewed as enabling the use of these environmental functions in such a way to maintain their availability indefinitely (Hueting & Reijnders, 1998). Environmental sustainability can therefore be explored through the review of each of these functions.

Emissions from several of human activities change the atmospheric chemical composition and trigger some processes that are inimical to the environmental sustainability. Carbon di oxide contributes 55%, methane 15%, nitrogen oxide 6% and CFC gasses 24% to the environment (Norgard & Christensen, 1994). The combined impacts of these gasses on the environment create the greenhouse effect and destroy the ozone layer. The consequences result in global warming and increase in the Ultraviolet-B (UV-B) radiation getting to the earth's surface. Global warming leads to climate change while the side-effects of the increased UV-B radiation include impairment of germinating plants and fall in the carbon fixing rate of one of the major global carbon sinks, marine plankton, among others (Brown et al., 2000; Goodland & Daly, 1996).

The sulphur dioxide and nitrogen released into the atmosphere from power plants, manufacturing processes and fossil fuel combustion react to form sulphuric and nitric acids that drop back onto the earth surface as acid rain. The acid rains through a complex process increases soil degradation and cause damages to plants and other biological species. Acid rain is also a catalyst for other chemical processes involving heavy metals such as aluminium, cadmium, lead, and mercury (Brown et al., 2000).

The destabilisation of the nitrogen cycle alone has the potentials of causing enormous damage to the ecosystem more especially the vegetation and soil (Brown et al., 2000). These complex processes combined, have the potentials of halting most of the environmental functions identified by Hueting in 1974. Deforestation is one of such phenomena with the capability of destroying the earth life support systems.

It is difficult to ascertain the exact area of forest and biodiversity species being lost continuously, however, an estimated 14 million hectares of forestland is lost annually with more than 90% occurring in the tropics. About 40% of the earth surface that used to be covered by forest some 8,000 years ago has now been dwindled by almost half. In 1997 and 1998 alone, an estimated over 5.2 and another 2 million hectares of forest were burnt to clear land in the Brazilian Amazonia and Indonesia respectfully. A trend like this generates a chain of damages that extends beyond the intended area, but also distorts the rainfall pattern and the biomass and thousands of species of creatures whose habitat has been destroyed (Brown et al., 2000). It also helps to offset the global CO_2 balance and increases the global warming, a trend that is entirely far from being sustainable. The risen temperature of the earth may be causing as much damage to the coral as the fire does to the forests. The sea surface temperatures (SSTs) are usually the indicators of the global warming. Nevertheless, the coral reef under water is very sensitive to temperature variations. The high temperature triggers a process called bleaching which damages the coral. Reportedly, approximately 70% of the coral in the Indian Ocean is dead (Brown et al., 2000). This pattern endangers the continuity of the functions of the oceans more especially the fishery. Other forms of biodiversity are alarmingly similarly endangered. There is an estimated 11% of all birds' species and 25% of all mammals classified as endangered (Brown et al., 2000). The sustainability of the world fresh water supply is equally under threat.

The inadaquacy and poor quality of water supply is the most critical to the construction industry, more especially in the developing countries. Majority of the population in the developing countries are experiencing scarcity of portable water supply (Onyenechere, 2004). Pumping technology has enabled the extraction of underground water for agricultural purposes at a rate that is higher than the rate of replacement by precipitation. While the water levels decrease, the food supply of hundreds of millions of the world population depends on this method for production. In addition, part of the irrigation water is diverted to cities for domestic and industrial purposes. This factor combined with the shrinking cropland area per person is another unsustainable practice that threatens the global food security (Brown et al., 2000). The story is the same for aquatic fishery as 34% of the world species are regarded as endangered.

It is not only water that is extracted from underground, but also the mineral resources that directly support several global economic activities.

There are divergent views on the possible role of the mineral resources deposit in limiting the global economic development. Gelb et al. (2012) believe that other ecological limitations such as climate change and water are more likely to constraint what they termed resource-based development than resources deficit.

As stated by Goodland and Daly (1996), there are two options for the inevitable global transition to sustainability, a calculated planned transition or a transition dictated by the biophysical limits. In any agenda for a planned transition to sustainability, creation of the right socio-political environment becomes a prerequisite.

2.1.6 Social Sustainability

The statement of WCED cited in section 2.1.3 above, i.e. poverty will make the poor to destroy their environment for survival, explained in simple terms, the interrelationship of environmental with the social sustainability; and therefore, the need for reduction of poverty in order to save the environment. This is even more emphasised if the Milanovic and Yitzhaki (2002) decomposition of the world income distribution is considered. It was reported that 78% of world's population are poor while only 11% are rich and another 11% middle class. In the perspective of consumption, the United Nations cited by Shah (2011) recounted that the world richest fifth consume 86% of the goods and services while the poorest fifth consume a paltry 1.3%. This brings to the fore the perennial question- can the poorest be uplifted for the sake of the environment?

The possibility of redistribution of resources from the rich to the poor is less likely to be politically acceptable despite the fact that sufficiency and non-material satisfaction being more important than consumption. Nevertheless, upgrading the living standard of the poor should not be compromised at the expense of the environment (Goodland & Daly, 1996).

Social sustainability therefore refers to reducing the inequality between the have and the have-not. This is usually attempted through upgrading the have-not to the level of the have. However, it is opined that this will not be practically achievable in the near future. Alternatively, there was an inclination towards the view of (Serageldin 1993 cited in Goodland and Daly, 1996) who explain that a per capita income of US $1,500- $2,000 in developing countries is capable of providing 80% of the basic welfare of the unachievable US $21,000 per capita income of the advanced countries.

There is also a need for distinguishing the idea of ‘equal opportunity’ associated with social equity from equality. The social equity can be expressed by the economic and social components of human well-being as identified by Boyden and Dovers (1997); and this include the ambitious list itemised below (Diesendorf, 2000):

- access to clean air and water
- adequate diet
- adequate dwellings
- personal physical and emotional security
- learning opportunities
- opportunities for small cooperative small-group interaction
- an emotional support network
- opportunities for creative behaviour
- an appropriate pattern of physical exercise
- an environment and lifestyle free of alienation, anomie, deprivation, boredom, loneliness or frustration.

Providing learning opportunities may be the key to accessing all the other components, as it was also captured in the eight objectives of the millennium development goals (MDG). The other objectives of the MDG are poverty eradication, gender equality, reducing child mortality and improving maternal health. Others are fighting HIV/AIDS, environmental sustainability, and global partnership for development (UNDP, 2013). Another significant aspect if poverty is to ever be eradicated is attitudinal change more especially towards population policies.

The United Nation estimated that the world population will reach 11.6 x 10^9 by the year 2150. This will be twice the world population in 1996. If at a lower population, about 20% of humanity is living above poverty level, then it will be more challenging to provide for twofold of such population in future (Goodland, 1995).

2.1.7 The Interrelationship of the Elements of Sustainability.

The three aspects of sustainability discussed in sections 2.1.4-6 may not necessarily be distinguishable from each other, there is an overlap. A sustainable development will seek to satisfy the socio-economic as well as environmental requirements for sustainability. The interplay of the three aspects of sustainability is illustrated in the diagram (Fig 6) adopted from Sullivan (2012).

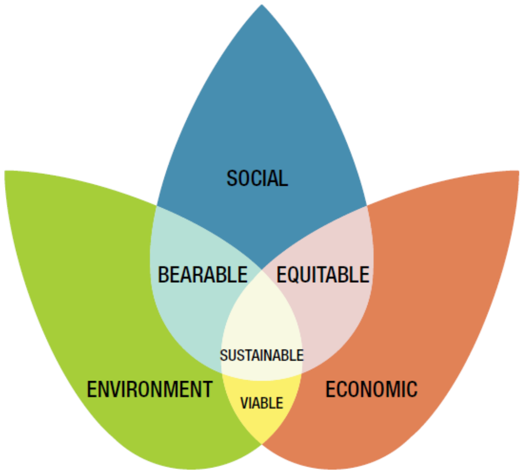


Figure 6: Sustainable development is the interaction of Social, Environmental and Economic factors (Adopted from in RIBA Guide to Sustainability in Practice 2012).

Traditionally, each of these entities is assessed exclusive of the others (FIG 7), however in sustainability thinking, the whole is viewed together as one phenomenon (Hart, 2010). In the traditional method, the economy for instance will be measured in GDP, pollution and waste in grams/person, and unemployment and poverty separately in percentage; in a sustainable model the trade-offs between the three are viewed as a whole.

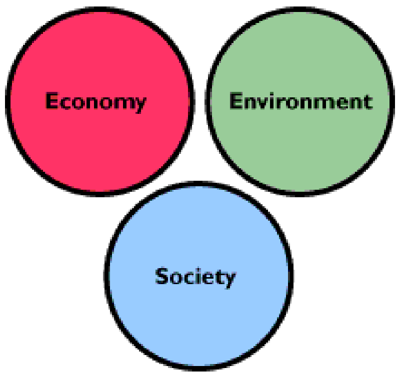


Figure 7: Traditional Approach where Society, Environment and Economy are considered as separate entities (Adopted from http://www.sustainablemeasures.com/node/42 2012).

As the economy is a segment of what make up a society and therefore exists within the society while the society in turn exists within the physical environment, another and probably better way of explaining the interactions of the three elements of the sustainability model is using concentric circles as shown in (Fig 8) below (Hart, 2010).

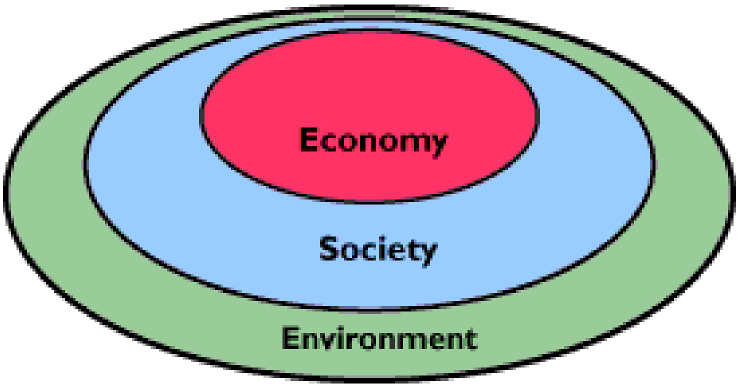


Figure 8: Sustainability Model Economy is considered to exist within the Society, and the Society within the Environment. Adopted from http://www.sustainablemeasures.com/node/26 2012).

As discussed in section 2.1.4 above, a compromise between environmental, economic or social sustainability is common place. According to this view sustainability is graded from weak to strong depending on the degree of substitution of natural capital with human-made capital. The possibility of neutralising the impacts of a particular project by others treated as a group or programme is likely to be more effective and economical. Where it is necessary, a project may be initiated purposely to absorb the impacts of some other projects (Hueting & Reijnders, 1998).

A trade-off in time and space is an idea whereby a compromise can be made at a particular time or space for a gain in future time or another place. However, this may not be practical sometimes, as the environmental processes are not restrained within the artificial boundaries suitable for human analysis. The artificial boundaries define the environmental management structure, which does not coincide with the natural ecosystem boundaries (Conway 185; Munasinghe 1993 in Thomas & Adams, 1997).

2.2 The Politics of Sustainability

The attendance of many of the word leaders at the environmental conferences notwithstanding (Brandon & Lombardi, 2011), there are reasons to suspect the sustainability program as really a global concern or interpret it as another attempt by the technologically advanced nations *(referred to as the North)* to give what is their exclusive business a global pigmentation.

Firstly, industrialisation was at the inception stage in most of developing countries. The greenhouse gasses emissions in developing countries (the South) are relatively small compared to their northern counterparts. There are reports that indicated eighty to eighty six per cent (80-86%) of the world resources is consumed by 20% of the world population (Inäcio;, 1999; Shah, 2011). While it is estimated that the average per capita resources consumption in the European Union may be up to 20 times more than that of most developing countries, it is half that of the US and Canada (Inacio, 1999). McDonough and Braungart (2009) ascertained that if everybody on earth is to use papers as much as a USA citizen, three times of all the trees on the earth surface will be required. Furthermore, the relative per capita consumption of energy in the developing countries ranges from 13 to 280 times less than that of the United States (Ehrlich and Ehrlich 1989 in Goodland and Daly (1996). These reasons among others may possibly be used as justification for the developing countries (the south) to dissociate from the blame and responsibility for environmental sustainability.

Additionally, there is the possibility of some eastern philosophies to disregard preservation of human race as a motivation to pursue a sustainable development agenda (Brandon & Lombardi, 2011). In addition to religious philosophies, other value systems such as business and community may be in conflict with the environment. As the concept of sustainability required a common motivation, the tendency for reluctant attitude by any section as in the first phase of the world environmental conferences may be very serious.

One of such attitudes is the collective position of contestation by the developing countries in the first major global convention and acclaimed starting point for the global action on environment: *the Stockholm Conference on the Human Environment* held in the Sweden in 1972 (NAJAM, 2005). The position of the developing countries at the conference was best articulated and expressed in the famous quotation of the former Indian Prime Minister Indra Gandhi, when she says: *"Poverty is the worst form of pollution."* This was the prominent view at the conference, and implied that the concern of the developing countries at the time was more of poverty than environment. However, this position was supposedly changed to participation and full engagement as demonstrated at the later conferences (Rio de Jeneiro in 1992 and Johannesburg in 2002) (NAJAM, 2005).

Irrespective of the political challenge posed by the proposed "contraction" of the over consumption by the developed countries and "convergence" of the world population at a sustainable consumption level (RIBA, 2009a, p. 2), it has been realised that environmental sustainability is the concern of both the developed and the developing countries (Goodland & Daly, 1996). The burden may however be more on the developed countries. The developed countries having contributed more to the environmental damage in the past, it is required presently to exhibit more commitment to sustainability. The emission of greenhouse gasses too will require more to be done by the developed countries being the largest transgressors. An action by the developed nations will serve as an inspiration to the developing countries. The south on the other hand will be concerned with environmental sustainability being the worst to suffer from environmental degradation, depletion of natural resources as well as the difficulty of tropical climates to be rehabilitated (Goodland & Daly, 1996).

The politics of the north and south notwithstanding, as stated by Goodland and Daly (1996), environmental sustainability is therefore universal and non-negotiable; and in the move towards sustainability, addressing the natural resources depletion and waste generation from the consumerism culture will play an important role.

2.3 Resources Depletion and Sustainability.

As stated in section 2.1.2 above, there are divergent views on the possible role of the natural resources deposit in limiting the global economic development. This is a perennial debate starting from the 18th century with the well-documented pessimistic view of the British economist Thomas Malthus who argued that natural resources would always constraint the growth in human population at an equilibrium state characterised by misery, starvation, and low wages. There were counter arguments to this view hinging on the possibilities created by science and technology, and decline in population growth due to improved economic welfare (Tahvonen, 2000).

In the late 19th to early 20th century, while the conservation movement of the United States was at its peak (Tahvonen, 2000), alternative views such as that of Hotelling (1931) attempted to invalidate the merits of regulating the exploitation of the non-renewable natural resources in the name of conservation for future generations. He theoretically demonstrated that sustained welfare based on the exploitation of non-renewable resources at optimal level was possible (Hotelling, 1931). In congruence with this view, other studies indicated how prices and technology interact to self-regulate the economics of resources (Barnett & Morse, 2013; Tahvonen, 2000).

Nevertheless, from the later half of the twentieth century attention has been directed towards studies on the possible outcome of economic growth that relies on non-renewable resources, largely influenced by fuel crises of the 1970s and further supported by influential studies such as the Meadows et al. (1972)'s *"limits to growth"* (discussed in section 2.1.2 above) and Dasgupta and Heal (1974)'s *"The optimal depletion of exhaustible resources" (Tahvonen, 2000)*.

On the other hand, beyond the depletion of high quality resources, extraction of materials for industrial application is usually associated with negative environmental impacts and wastes generation. This trend threatens the same opportunity for future generations as the limited and most useful resources are continuously converted to wastes.

2.4 Consumerism and Waste Generation.

According to Leonard (2010) there are five stages in the linear system of the economy of materials driven by consumption, i.e.– extraction, production, distribution, consumption, and disposal. However, this linear system cannot be sustained in a finite world with limited resources. While it was reported that in last two decades of the 20th Century and the first decade of the 21st Century alone one-third of the world natural resources were consumed (Leonard, 2010), the movement of materials through these stages makes an imprint on social structures, the physical environment, and local economies. The natural resources exploitation for raw materials damages the ecosystem, including 80 per cent of the original vegetation, biodiversity, soil and pollution. Moreover, 99 per cent of the products may end in landfill as a waste in less than a year in a linear pattern described by (McDonough & Braungart, 2009) as cradle-to-grave.

There are reports (for example Wuppertal Institute, 2000) that the movements of materials caused by human activities double that of the natural factors combined together. The fact that the earth is a closed system in terms of materials, the carrying capacity for such activities is being exceeded. Consequently, the need to protect the environment and the world disparity in resources availability justifies the quest for improved materials efficiency and reduced demand, whereby it is recommended that the material flux by human activities should not exceed the natural flux (Kibert, 2005; Kibert et al., 2000).

As a remedy to the threat on materials stock, a concept of dematerialisation of economies and materials production was initiated. It was postulated that materials efficiency, measured in materials input per service unit (MIPS) can be improved ten times: referred to as “factor 10”. This can be achieved by closed-loop materials cycle and minimising virgin material inflow. It is noted that dematerialisation is not a new phenomenon, as the intensity of use index (IOU) used by industry is the same as dematerialisation derived by profitability. However, the aim of dematerialisation will be defeated if achieved through processes with negative environmental impacts or lack of recyclability. It is therefore suggested that dematerialisation should go beyond (IOU) index and focus on reuse and recycling as part of the aimed closed-loop system. While it is acknowledged that humans may succeed in achieving dematerialisation using technology, it is however important to note the limitation of dematerialisation in addressing the wider environmental issues. Dematerialisation should also be accompanied with de-energization, decarbonisation, and detoxification of the industrial systems. There is also a view that for world to be sustainable, quality should be prioritised over quantity and over consumption and wastage should be discouraged (Kibert, 2005).

Another solution to the material wastage is the production concept of recycling materials and structuring human industrial production system in the style of natural ecological system that produces zero waste or cradle-to-cradle production (McDonough & Braungart, 2009). *"Seen from the perspective of industrial ecology, waste can be defined as resources in the wrong place- resources that have gone astray. The goal is to bring all resource flows back into closed loop where they circulate within the human economic system, so that the extraction of new raw materials as well as final discarded waste becomes an absolute minimum" (McDonough & Braungart 2002 cited in Berge, 2009, p.14).* This is the underlying concept of sustainable waste management.

2.5 Waste and Sustainable Waste Management.

2.5.1 Definition and Classification of Waste

There are several attempts to define what is a waste, nevertheless some of the most common include the European Council Directive 91/156/EEC definition which consider waste as - *"any substance or object which the holder discards or intends or required to discard"* (Osmani, 2012). Similarly, the Control of Pollution Act 1974 puts it as *"any substance or article which requires to be disposed of as being broken, worn out, contaminated or otherwise spoiled or any substance which constitutes a scrap material or an effluent or other unwanted surplus substance arising from the application of any process."* Additionally, World Health Organisation (WHO) defined waste as *"something which the owner no longer wants at a given place and time and which has no current or perceived market value"* (Royal Commission on Environmental Pollution, 1985)." However, Nowak et al. (2009), summarised the definition of waste as *"materials for which the generator has no further use for own purpose of production, transformation or consumption, and which he*

discards or is required to discard". However, for the purpose of this study the World Health Organisation's definition of waste is adopted.
On the other hand, a material for disposal deserves attention for it usually constitutes a hazard to humans and other living organisms. Furthermore, it signifies a destruction of the finite natural resources and spaces for amenity and recreation (Royal Commission on Environmental Pollution, 1985). The negative impacts generated by the materials that are turned into waste are largely determined by its characteristics and classification, and the classification is achieved according to the way it is generated, or the method it is handled.

According to its source, a waste may be classified as agricultural, commercial, household, or industrial; municipal, mining, or sludge waste. While according to the way it is handled a waste can be biodegradable, refuse, civil amenity, or difficult; special, hazardous and recyclable (DOE, 2012a; Nowak et al., 2009; Royal Commission on Environmental Pollution, 1985).

As most of the materials that are discarded as waste are sourced from the finite natural resources, disposal is the last option and should be avoided. However, many of the materials can possibly be reused or recycled. Additionally, the materials may also be utilised in some beneficial processes such as energy recovery by incineration, sometimes termed as "waste to energy" (DOE, 2012b; McDonough & Braungart, 2009).

2.5.2 Waste Management Methods

There are different methods of managing wastes, however, according to the EU Waste Framework Directive (WFD) 2008/98/EC some of the methods are more favourable to others in terms of ecological benefits. In ranking order, reducing the generation of waste from source is the most preferable option. The next preferable approach for treating the unavoidably generated waste is to reuse the material in one way or another. Nevertheless, not all the waste generated may be suitable for reuse, therefore, the next preferable method is to renew the materials through a recycling process most appropriate. The concept of giving priority to the most preferable to the least preferable approaches of waste management is famously known as the *Waste Hierarchy* usually represented as a *Waste Pyramid* diagram as in Fig 9 (DOE, 2012b; Gharfalkar, Court, Campbell, Ali, & Hillier, 2015; Kibert, 2005; McDonough & Braungart, 2009; Nowak et al., 2009; Williams, 2015).

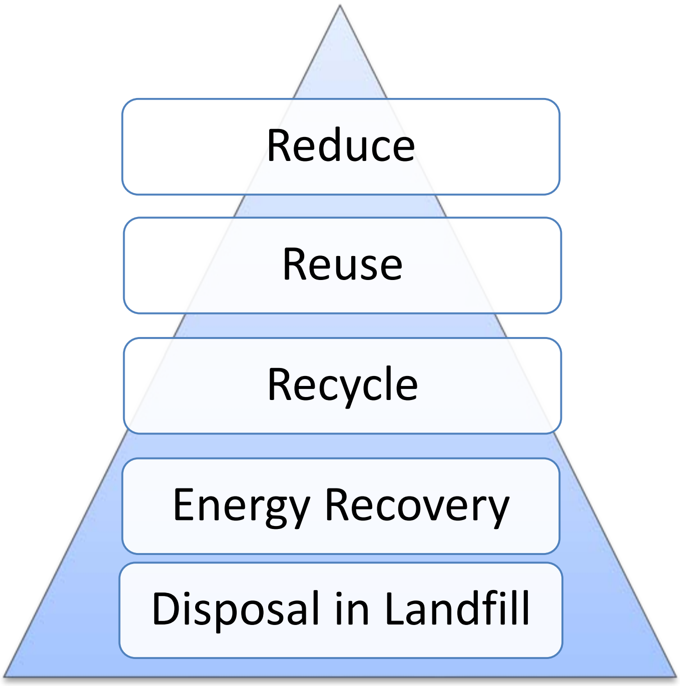


Figure 9: Waste Pyramid (Adopted from DOE, 2012; Kibert, 2005; Nowak et al., 2009)

The efficacy of the waste hierarchy in reversing material throughput is arguably questioned in many discourses (Bartl, 2014; Gharfalkar et al., 2015), nonetheless it remains the most widely accepted framework for sustainable waste management. The features of the waste hierarchy are discussed below.

2.5.2.1 Reduce

There are four ways of preventing or reducing waste, production with minimum resources, extending the life span of products, reusing materials without restoration efforts, and minimising hazardous materials (DOE, 2012a).

In the opinion of Weiszackor, Lovins and Lino cited in Kibert (2005), one quarter of the resources currently consume by humanity is adequate for sustainable living. Lee Eng Lock on the other hand, believes that 90% of the energy consumed by mechanical systems may not be required as only 10% could be enough with the appropriate technology (Kibert, 2005). This is doing more with less termed as "eco-efficiency" and sometimes "dematerialisation" in the wordings of McDonough and Braungart (2009). Waste prevention starts from the design stage of a product (DOE, 2012b; McDonough & Braungart, 2009), however, some quantity of waste may be unavoidable and therefore will require another approach.

2.5.2.2 Reuse

In line with the WHO definition of waste as what is adjudged to have no current or perceived market value and the titleholder cease to desire at a particular place and time (DOE, 2012b), then the situation will be reversed if any of the two conditions is substituted. This implies that, when a market value or desire for an item by the original or any other owner is restored, it ceases to be a waste but a commodity. Reuse, is therefore, another way of expressing a renewed value and interest in the particular item in question and is usually done in two ways. According to the DOE (2012b, p. 8), when a material is used without undergoing any process, it falls into the first and best category of waste management approaches - prevention. However, if the whole or part of an item undergoes any process of checking, cleaning, refurbishment, or repair, then it is classified under the second position in the hierarchy of waste management approaches. The feasibility of reusing an item can also be improved from the design stage (DOE, 2012b; McDonough & Braungart, 2009).

2.5.2.3 Recycle

Material recycling is the third preferable waste management approach in the waste hierarchy. According to the EU Waste Framework Directive, recycling refers to the material recovery by reprocessing of waste materials into products (Bartl, 2014; Kibert et al., 2000). It provides a solution whereby the material otherwise designated as a waste can be used as a raw material for the production of another material (Kibert et al., 2000).

Recycling adopts the idea of industrial ecology which Ayres and Ayres, (1996, p.6) described as making raw material in one process out of the waste of another process as inspired by natural ecological processes such as carbon cycle. The objective of recycling as described by Mcdonough and Braungart (2009) is to minimise the need for sourcing raw materials and bringing all resources otherwise designated as waste back into economic cycle. Wastes are rather viewed as resources in the wrong place.

The ability of repeatedly restoring material to its original state without losing any value like the case of steel can be described as closed-loop material cycle (Sassi, 2008); whereas reprocessing of a material into another product of lower value which may not be able to be recycled again is called downcycling (Kibert, 2005; McDonough & Braungart, 2009; Sassi, 2008). The reprocessing of material into another of higher value is termed upcycling (Kibert, 2005). However, some products are recycled through the natural process of biodegradation (Bartl, 2014; Sassi, 2008).

According to McDonough and Braungart (2009), there are two types of metabolism activities in the universe, the biosphere- natural metabolisms or cycles and technosphere- industrial metabolisms or cycles. While an exchange of materials between these two cycles can be observed, the concept of waste can be eliminated if products can fit back into one of the two cycles as a raw material (McDonough & Braungart, 2009).

There are four (4) key issues concerning recycling through industrial processes, these are the potentials for infinite recycling, the efficiency of the process, the quality of the product and the threat posed by the process to the environment and health. On the other hand, the European Norm EN 13432 standard prescribed some requisite requirements for industrial reprocessing (Sassi, 2008).

While some materials can be recycled indefinitely without losing their quality, some other materials will require an addition of some fresh materials to restore their original quality. EN 13432 stipulates 10% maximum quantity of such fresh materials. There are records of materials that do not lose their quality through the recycling process, however for the other category, it should not be more than 10%. In England and Wales, the hazards associated with the recycling processes should be controlled within the limits set in Pollution Prevention and Control Regulations 2000 (Sassi, 2008).

Wastes from materials that are biodegradable on the other hand, may be treated by the natural process of composting - disintegration and consumption by microorganisms or any other living organism (McDonough & Braungart, 2009). This is superior to landfilling more especially if the two criteria stipulated by the British Standard (BSI, 2007) and European Norm (EN) 13432 is satisfied. This includes a full disintegration within three months and 10% maximum material waste; and the disintegration process should not be hazardous to human health and the environment. Associated side effects may not be avoidable however, which EN 13432 conditionally accommodates more especially if relatively lower than the side effects of processing virgin material (Sassi, 2008). Conversely, some materials are not biodegradable and not suitable for any form of recycling, but can be managed through other systems such as energy recovery by incineration.

2.5.2.4 Energy Recovery by Incineration

This is another approach of waste treatment that is below recycling, whereby energy is generated from waste (Berge, 2009). It is sometimes described as “waste to energy” and considered superior to landfilling. As the idea of waste management and the ultimate goal of eliminating waste is conservation of resources, waste to energy may not be considered as a recommendable approach, because valuable materials are rather destroyed on the long run (McDonough & Braungart, 2009, p. 55). Nonetheless, burning is not the only technic used to generate energy from waste.

There are three ways of recovering energy from waste: energy recovery as heat, and by conversion of the waste into fuel known as Waste Derived Fuel (WDF) or Refused Derived Fuel (RDF), and as methane gas recovered from dumping grounds. The use of waste to generate heat is usually done from plants for mass incineration whereby the heat is used for district heating schemes, factory space heating, and for some manufacturing processes. It is not recommendable to have an incineration plant without a ready market for the heat to be generated- a reason that makes the WDF more versatile (Royal Commission on Environmental Pollution, 1985).

It is possible to store WDF to be used at the most convenient time and by any interested party, not necessarily any particular customer. While the Pellets can be used in the conventional boilers, the shreds are more suitable for use in the large combustion units like kilns. However, WDF are unpopular with customers relative to coal (Royal Commission on Environmental Pollution, 1985). As noted by McDonough and Braungart (2009, p. 55), another side effect of generating energy from WDF is the risk of toxic gasses emission associated with the process. The other source of energy from waste is in the form of the gas - methane.

Methane gas can be harvested for use as a fuel and may constitute up to 65% of the gasses generated from landfills. Additionally, methane gas is a pollutant that is associated with several side effects including damages to plants, and possibility of explosion. Therefore, harvesting it has the potential to serve the dual purpose of controlling pollution and generating energy. Even though there were success stories of exploiting methane in commercial quantity, a stable production from any landfill may not be guaranteed. Moreover, the processing cost may make its exploitation unfavourable to a commercial venture (Royal Commission on Environmental Pollution, 1985). Contrariwise, should there be landfills in the future?

2.5.2.5 Landfilling

Dumping waste in the landfill is the least preferable method of managing waste, and should be avoided for the associated negative environmental impacts. As stated in section 2.5.1, landfills usually constitute a hazard to humans and other living organisms. Furthermore, it signifies a destruction of the finite natural resources and spaces for amenity and recreation (Royal Commission on Environmental Pollution, 1985). In the UK there is landfill tax that is designed to discourage waste going to the landfill (Secretary of State for Environment, 2005). In line with the sustainability principles landfills should cease to exist.

2.5.2.6 Discussion

From the foregoing discourse, it can be argued that the most sustainable waste management techniques in line with sustainability principles and the idea of waste hierarchy are the 3Rs of *"reduce", "reuse",* and *“recycle”* in order of preference. Thereafter, the options of “energy recovery” may be considered as the least sustainable alternative while “landfill” is discouraged (McDonough & Braungart, 2009). Nevertheless, is this principle applicable to the massive amount of waste generated from building demolition activities?

Buildings and other man-made structures may possibly be similar to the other products in making imprints on the environment, nonetheless, it is argued that buildings are unique and *“one of a kind”* product that differs from manufactured products in many respect (Koskela, 2000; Solís, 2009). In the following sections (2.6 and 2.7) the role of the built environment in the sustainability agenda in general and demolition wastes in particular will be discussed.

2.6 Sustainability and the Built Environment

The Museum of London claims that it's collection starts from the time when animals roamed the Trafalgar square (Museum of London, 2013). A curious visitor will surely ask such questions as, "where are the animals?" "What happened to their homes (habitat)?" This is a typical example of the extents of the destruction the built environment can do to the natural environment and the ecology.

Aaron Betsky cited by Belogolovsky (2009) described the idea of man-made structures with limited sunlight, restricted air and views substituting the once open land with abundance of sunlight and fresh air in a perfect harmony with the skyline as the *"architecture's original sin".* The facts that above 30% of the global fossil fuel carbon emission, 40% of the global acid rains, energy consumption, greenhouse gasses, and solid wastes are associated to buildings bring architecture into collision with nature (Belogolovsky, 2009). The response by evolving a new dimension for architecture that will be in harmony with natural ecology started to resonate among some of the architects, designers and thinkers of the twentieth century. Among such people are Buckminster Fuller, Frank Lloyd Wright, Richard Neutra, Lewis Mumford, Ian Mcharg, Malcolm Wells and John Lyle (Kibert, 2005).

The geodesic dome, dymaxion house, and car are among Buckminster Fuller's inventions that utilises his eco-friendly, material, and energy sensitive concepts. He is also among the first writers to interrelate environmental with economic and social issues. Through inventions and writings, he demonstrated an advocacy for green architecture in the form of design for deconstruction, the use of renewable energy, resources conservation, and the negative impacts of wastes to the biosphere. Fuller's ideologies and works became very influential that he is sometimes called the father of environmental design (Kibert, 2005).

The designs of Wright demonstrated an effort to integrate the building with the site, the environment, the nature of the materials and the life of the inhabitants. Neutra however, expounded the special attachment of humans to nature termed as *“biophylia”* as well as advocated the idea of imitating nature. Such ideas as buildings consuming their waste, maintaining themselves, and minimising the use of asphalt and concrete are all associated to Wells. Lyle on the other hand advocated for ecological landscape design (Kibert, 2005). In brief, what is common among all these people was their advocacy for a shift from what used to be the convention to buildings that are friendlier to the ecology, and with minimum environmental impacts such as carbon emissions and resources consumption.

2.6.1 Carbon Emission and the Built Environment

Another grievous sin of architecture in addition to what Betsky described as the architecture’s original sin is the contribution of buildings to global warming and climate change through carbon emission. In addition to the energy consumed in the construction, operation and demolishing phases, there is the embodied “energy” consumed in the manufacturing of the building materials (Berge, 2009). Nearly half of the estimated 560 Million UK carbon emission is from buildings in the form of energy consumption. Therefore, the Building Emission Rate (BER) and Dwelling Emission Rate (DER) in $kgCO_2/m^2/yr$ is another way of assessing the environmental performance of buildings. A “Zero Carbon” building should satisfy the requirements for level six of the Code for Sustainable Homes. This will require on-site generation of electricity equivalent to the amount used in the building. Energy performance standards for buildings are being gradually incorporated into building regulations. Maximum carbon emission standards are prescribed in building regulation (HM Government, 2016; RIBA, 2009b, 2009c, 2009d; Zero Carbon Hub, 2013). All these are part of the mitigation efforts against climate change. Nevertheless, if buildings were to generate all the energy it requires, another significant ecological impact attributed to buildings is the enormous material resources committed and wasted by building activities.

2.6.2 Resources Consumption and the Built Environment

Resources depletion is among the most critical issues in the global sustainability quest. This is even more emphasized as noted in the Brundtland (1987) report, for sustainable progress and human survival, there is a need for action to manage the global finite resources. *"Doing more with less"* in the words of McDonough and Braungart (2009) referring to eco-efficiency as one of the foremost outcomes of the 1992 Rio Earth Summit. This brings the construction industry into limelight, as it is probably the highest resource consuming human activity. It is reported by Kibert (2005, p. 55) that according to certain approximations, ninety (90) per cent of all materials ever extracted by humans were used for construction. The famous 20th century American engineer- Richard Buckminster Fuller is known to remark while speaking to his colleagues *"how much does your building weigh?"* (RIBA, 2009a).

It is not only Fuller that is conscientious of materials consumption in man-made objects, in 1997 Weiszackor, Lovins and Lino in their theory of factor 4 postulated that with ¼ of the current resources consumption humanity can live sustainably if appropriate technology is applied. Friedrich Schmidt-Bleek rather put it at one tenth. While in the same line, Lee Eng Lock believes that with change in approach only one tenth of the energy use in the design of the present mechanical systems in building is actually required (Kibert, 2005, pp. 46-47). Contrarily, the *"incursion"* of human construction activities on the world's materials stocks is not only limited to the over consumption, but how the materials are handled when considered no longer useful.

In the US, more than 325 million tons of construction and demolition waste is generated annually (CDRA, 2016), and as observed by Kibert, (2005), many of the waste will be occupying landfill space, hampering water supply, and bringing an increase in the construction cost. In the UK, the story is not much better, as the UK Green Building Council (2013) reported that 24% of total waste (three times than the total household waste) amounting to 109m tonnes annually is the by-product of construction activities including demolition. The report went further to reveal that while about half of this is reused or recycled, the other part remains unused. In construction, the issue of materials consumption and waste handling is considered very important that the first three of the seven principles of sustainable construction articulated by Conseil International du Batiment (CIB) are directly centred about the same issues (Kibert, 2005). This is in support of the paradigm shift towards ecologically sustainable building construction and end-of-life management.

2.6.3 Green Buildings or Ecologically Sustainable Buildings

A green building is sometimes interchangeably referred to as high-performance building, ecological design, ecologically sustainable design, or simply green design as discussed by Theis as cited in Kibert (2005). The emergence of these new concepts surely indicates a paradigm shift from the traditional approach that is usually adopted in the built environment. Nevertheless, there are variants of this new concept, which may differ slightly from each other as shown in their definitions.

The U.S. Green Building Council (2002) defined green buildings as “buildings that are designed, constructed, and operated to boost environmental, economic, health, and productivity performance over that of conventional building.” Another definition of green buildings is given as “healthy facilities designed and built in resource efficient manner, using ecologically based principles” (Kibert, 2005).

The term sustainable design according to McDonough (1992) is "the conception and realisation of environmentally sensitive and responsible expression as part of the evolving matrix of nature."

The U.S. office of the Energy Efficiency and Renewable Energy (EERE) on the other hand, defined high performance building as one that uses whole-building design to achieve energy, economic and environmental performance that is substantially better than standard practice (Kibert, 2005). The goal of the whole-building design according to the National Institute of Building Sciences (2012) is to create a successful high-performance building by applying an integrated design and team approach to the project during the planning and programming phases.

Commonly, these terms evolved as a response to climate change by developing a survival technique called *"adaptation",* while cutting or completely halting the processes that led to the global warming is referred to as *"mitigation"*. The need for both adaptation and mitigation will definitely affect the manner by which we plan, erect, handle, and utilise structures (RIBA, 2009b). Several principles were conceived to guide activities in the built environment to achieve the environmental goals. Among such guides is the Macdonough Hannover Principles, which identified nine issues that form the template for ecological design. These include the rights of humanity and nature to co-exist, interdependence, relationship of sprit and matter, and responsibility for the consequences of design. Others are creation of objects of long term value, elimination of the concept of waste, natural energy flows, limitations of design, and knowledge sharing (McDonough, 1992).

Another set of guidelines is the LEED based Local Government Sustainable Buildings Guidebook and Sustainable Building Technical Manual. The issues covered in the manual are categorised into three. The first category is *passive solar design*, which consists of daylighting, building envelope and renewable energy. While, building commissioning, acoustics, indoor air quality, HVAC, electrical and plumbing systems are classified under the second category- *building systems and indoor environmental quality*. The third category covers the aspects of *materials and specifications* (Kibert, 2005).

BREAM on the other hand is an internationally recognised system for assessment and certification of the sustainability of building and infrastructural facilities. According to this system, the sustainability of built facilities is measured according to 10 parameters including energy, health and wellbeing, innovation, land use, materials, management, pollution, transport, waste, and water. Each of these parameters is further subdivided into issues that can be assessed to earn credits for certification. There are over 500,000 BREAM certified buildings and over 2 million registered for certification in 77 countries worldwide (bre, 2017).

Additionally, the RIBA (2009d) identified six (6) principles of low carbon design to include the appreciation of the energy use pattern, application of high efficiency services, minimising energy demand through building form and fabric, and energy management within building. Others are paying attention to insulation and air tightness, and the use of renewable energy system (Fig 10).

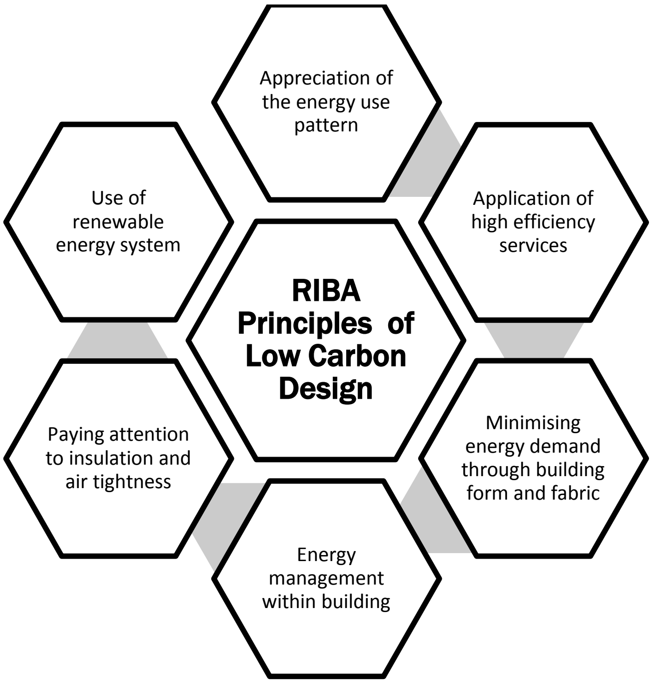


Figure 10: RIBA six (6) Principles of low carbon design.

On the other hand, the transition from the traditional approach to sustainable built environment should also involve sustainable management of construction and demolition waste.

2.6.4 Demolition Waste Management:

"Construction and demolition waste is a material which needed to be transported elsewhere from the construction site or used on the site itself other than the intended specific purpose of the project due to damage, excess or non-use or which cannot be used due to non-compliance with the specifications, or which is a by-product of the construction process"

(Skoyles & Skoyles, 1987)

In principle, the management of construction and demolition wastes is largely similar to solid waste, nevertheless, the application of the principles of sustainable waste management technique may be slightly different as will be discussed:

Reducing Demolition Waste

Similarly, applicable to the construction waste in general and demolition waste management in particular, is the principle of reduce, reuse and recycle as in the first three of the CIB seven principles of sustainable construction (Kibert, 2005). Reducing demolition waste usually involves deliberate design efforts or design for deconstruction (DFD), careful purchase of materials, and waste accountability clauses in agreements with contractors and subcontractors (Kibert 2005, pp. 357-360; Sassi, 2008). However, Berge (2009, pp. 8-11) identified four (4) ways of minimising the need for materials and waste generation from building activities. These are adapting buildings for different purposes and prolonging their usefulness period, application of lightweight construction materials and methods, and minimising the materials “loss factor” in construction exercises by conscientious management approach. The other is durability of materials in use and during construction (Berge, 2009).

Reusing Demolition Waste

Reuse of materials has been entrenched in the construction industry for sometimes; exhibition pavilions are a typical typology of structures that are designed to be demountable and reused in different location. Some examples include the Crystal Palace, the British and Venezuelan pavilion at the Seville Expo’92, and the Millennium Dome O2 arena. The Crystal Palace was first assembled in 1851 for an exhibition at Hyde Park, and later enlarged and reassembled in a different location in London in 1854 (Chilton, 2009). Moreover, there is renewed enthusiasm in reusing materials in construction (Rao et al., 2007), including the reuse of aggregates in concrete (Brito & Saikia; Rao et al., 2007), and mission statements by trade associations such as the American Construction and Demolition Recycling Association (CDRA, 2016), which is promoting the recovery of over 325 million tonnes of construction and demolition waste in the United States. There are publications canvassing for a new life for an old wood (Fast, 2001; Pacheco-Torgal, Tam, Labrincha, Ding, & de Brito, 2013), and private entrepreneurs promoting the reuse of building materials (Eat Sleep Live Ltd, 2016; PGT International Limited, 2016; Pinterest Ltd, 2016).

The obstacles to the reuse of building materials are lack of standards for the products and risk of damage during deconstruction exercise. However, as new approaches to design and building for deconstruction (DFD) are emerging these problems are likely to be minimised (Berge, 2009; Kibert 2005, pp. 357-360; Sassi, 2008). Materials that may not be useful in any other way, the second best option will be recycling.

Recycling Demolition Waste

Material recycling in the construction industry is decided by the nature of the particular material in question. Steel can be recycled by an indefinite number of times, while it is reported that 60% of steel in the UK is recycled and may be higher in other countries. Aluminium recycling operates at about 85.7% efficiency, due to the losses in mass in the recycling process through oxidation and production inefficiencies. Plasterboard is not friendly to recycling despite its common application for internal finishes. Masonry elements, roof tiles, and thermo-setting plastic materials that may not be friendly to recycling can easily be substituted by other materials or downcycled in some circumstances. A typical example of downcycling in construction is reprocessing of masonry to hardcore (Sassi, 2008).

Reportedly, three tonnes of concrete per person is used annually worldwide making it the most used artificial material. While aggregates make up the larger constituent (75%) of concrete, recently the practice of using recycled aggregates in concrete is becoming more acceptable in many countries as another approach for sustainable resources utilisation. The effects of the recycled aggregates on the various properties of concrete have been established by researches and incorporated into codes and standards in not less than ten countries. The recycled wastes used as aggregates are usually from manufacturing processes, and construction and demolition (Brito & Saikia, 2013).

2.7 Demolition Waste in the Context of the Nigerian Construction Industry

The statistics that in the UK an annual 90-120 million tonnes of waste is generated from construction and demolition (C&D) (Osmani, 2012; UK Green Building Council, 2013) might be on the decline, nevertheless the Waste Framework Directive target of recovering 70% of C&D waste by the year 2020 (DEFRA, 2011), suggests that there is much to be desired. Similarly, the Construction and Demolition Recycling Association efforts to recover over 325 million tonnes of construction and demolition waste in the United States supports the statistics of producing an approximately 140 million tones of construction and demolition waste (CDRA, 2016; Kibert, 2005). On the other hand, it was reported that for over 25 years Japanese have been engaged in research to find out ways to recover materials from building demolition without any practicable outcome (Rao et al., 2007, pp. 72-73).

Contrarily, studies in Nigeria suggest that construction and demolition wastes are not part of the solid waste streams in the Nigerian landfills (Nabegu, 2008a; Nabegu, 2010; Nabegu, 2008c). In another study that evaluates waste control measures in the Nigerian construction industry by Wahab and Lawal (2011), the authors cited statistics from different sources indicating the percentage of construction waste in the landfill for the United Kingdom, Australia, United States, Chile and the European Union without any such data for Nigeria despite being the subject of their study. Dania, Kehinde, and Bala (2007) reported that most construction managers in Nigeria lack the basic understanding of waste management practices, which indicates the low priority attached to the construction and demolition waste in Nigeria. Additionally, the *National Environmental (**Construction Sector)** Regulations, 2010. S. I. No. 19, which* according to Ladan (2012) was specifically targeted at the Construction Sector to minimise pollution as a priority rather than wastes. In another regulation, *National Environmental (Sanitation and Wastes Control) Regulations, 2009,* there was no mention of the Construction and Demolition Waste.

On the other hand, while efforts for recovering materials from construction and demolition wastes is gathering momentum in other societies (Rao et al., 2007), in Nigeria this is not a priority as there is virtually zero demolition wastes presently; the by-products from building demolition are treated as merchandise in an industry comprising of different stakeholders, creating economic opportunities and employments. The markets for the salvaged materials are familiar to the locals. This naturally evolved process has not been documented in literature, hence the need for this research.

Whilst solid wastes management in developing countries is normally assumed to be wholly motivated by economic factors (Schneider & Ragossnig, 2014), in this study the phenomenon of the building demolition waste management will be considered in-depth using the benchmark of the best practices used in the other industries.

2.8 Conclusion and Link

The need for humans to live sustainably on earth becomes imperative as contained in the message of the report for the Club of Rome (Meadows et al., 1972). Despite the initial doubts demonstrated mostly by the developing countries (NAJAM, 2005), sustainability has indeed become the man’s major issue of the twentieth century (RIBA, 2009b). The careful management of resources is the mainstay of sustainability, and entails intricate and interrelated environmental, and socio–economic facades. Nevertheless, one of the major concerns of the sustainability movement is the natural resources depletion.

The threat for the depletion of the natural resources is aggravated by a consumerism culture most especially in the economically advanced countries. It is now clear that the traditional pattern of extraction, production, distribution, consumption and disposal of materials cannot be supported by the earth indefinitely (Leonard, 2010). It is therefore necessary to find solutions to return the resources otherwise considered as wastes back to the economic cycle in a new paradigm described by McDonough and Braungart (2009) as cradle-to-cradle as opposed to the traditional cradle-to-grave system. The practical application of this philosophy requires that generation of wastes should be reduced as much as possible, then materials should be reused, where it cannot be reused it should be recycled.

On the other hand, the construction industry and the built environment are major contributors to the depletion of resources. This is evident in the enormous amount of construction and demolition wastes generated annually most especially in the economically advanced countries. In the US one third of total solid waste totalling to about 140 million tonnes annually is of construction and demolishing waste (Kibert, 2005), while in the UK the story is not much better, as the UK Green Building Council (2013) reported that 24% of total waste (three times than the total household waste) amounting to 109m tonnes annually is the by-product of construction activities including demolition. Contrarily, in Nigeria the situation is otherwise different, there is virtually zero demolition waste; a situation that makes the Nigerian practice appear to be more sustainable.

Furthermore, there is an argument that the construction industry, despite being unique and distinct, can learn best practices from other industries more especially where it is considered lagging behind. Therefore, in the following chapter, the best practice models of the end-of-life management of resources will be examined for the feasibility of transferring the practices to the construction industry.

Chapter 3 Lesson from other Sectors for the End-of-life Management of Materials

"We see that construction has two choices: ignore all this in the belief that construction is so unique that there are no lessons to be learned; or seek improvement through re-engineering construction, learning as much as possible from those who have done it elsewhere" (Egan, 1998, p. 18).

3.1 Introduction.

The evaluation of construction in comparison to the manufacturing industry has been the theme of many writings (Koskela, 2000; Solís, 2009). The hypothesis commonly adopted is that the construction industry is behind and should learn from other sectors. Traditionally the construction sector is rather described as a “conglomerate of industries” or “meta-industry” characterized by many inadequacies and paradoxes, however with aptitude for creativity (Solís, 2009). The hallmark of the construction industry as being *one-of-a-kind*, in-situ, with inconstant personnel (Koskela, 2000), and primarily as a process with the building as a secondary product (Solís, 2009), further emphasizes its uniqueness and the need to learn from other sectors. Moreover, while the clientele is another complex system (Bertelsen & Emmitt, 2005), the industry is identified with complex and inefficient operations, specialized but interdependent activities that are loosely coupled with over lapping and long lead times. Other unique features of construction are frequent variations, conflicting loyalties, and repeating defective work rather than discarding. These peculiarities frustrate the solicited quest for achieving the increased efficiencies; control, quality, productivity, and production cost akin to manufacturing (Solís, 2009), and therefore justifies the idea of learning from other industries.

Probably the most successful effort to import concepts from other industries into the construction industry is in the search for a production theory suitable to construction with improved performance (Bertelsen, 2004). The seminal work of Koskela (2000) which advocates the three paradigms composite model referred to a *Transformation-Flow-Value* (TFV) theory is a precursor to the development of the idea of lean construction. Lean construction is another approach for achieving improved quality, reduced cost, enhanced process, safety and working condition largely adopted from the manufacturing industry (Bertelsen, 2004). Prefabrication is another alternative for improving the inefficiencies associated with construction by shifting most of the activities to factories, while the site activities are reduced to assembling (Bertelsen, 2004).

Additionally, in agreement with the idea of construction learning from other sectors, Sanvido and Medeiros (1990) proposed an abstract model for integrated building process that compares with the corresponding computer-integrated processes used in manufacturing. These processes were broken down into business and management processes required to justify the provision of a building facility; then defining owners need and the methods for realizing those goals, and then providing the technical documentation necessary for the construction and tendering activities. Thereafter, the construction and operation phases of the facility (Sanvido & Medeiros, 1990).

Whilst in the foregoing was the review of the successful initiatives in improving construction as a product or as a process by imitating the manufacturing sector, nevertheless, there have been no commensurate efforts to improve the end-of-life management of buildings by learning from the manufacturing or other sectors. The need for sustainable practices in construction and resources conservation in particular further emphasize the requirement for transfer of ideas from one sector or culture to another. In this chapter, the potentials of adopting sustainable best practices to construction from the end-of-life management in automobiles, aircrafts, cell phones, ships, nuclear sectors, and the natural ecological system will be explored.

3.2 Lessons from the End-of-life Management of Automobiles

There are four phases in the life cycle of all products in general: - materials production, manufacturing and assembly, use and service, and end-of-life management (Fig 11). The end-of-life of automobiles, as in other products, may be sustainably managed by remanufacturing and/or reusing, or recycling (Keoleian, Kar, Manion, & Bulkley, 1997; Mayyas, Qattawi, Omar, & Shan, 2012). Automobiles are probably the most recycled products, as was reported in the United States in 1997 that 94% of all retired automobiles were recovered and recycled. The recycling of automobiles usually involves dismantling, shredding, and materials separation stages (Keoleian et al., 1997).

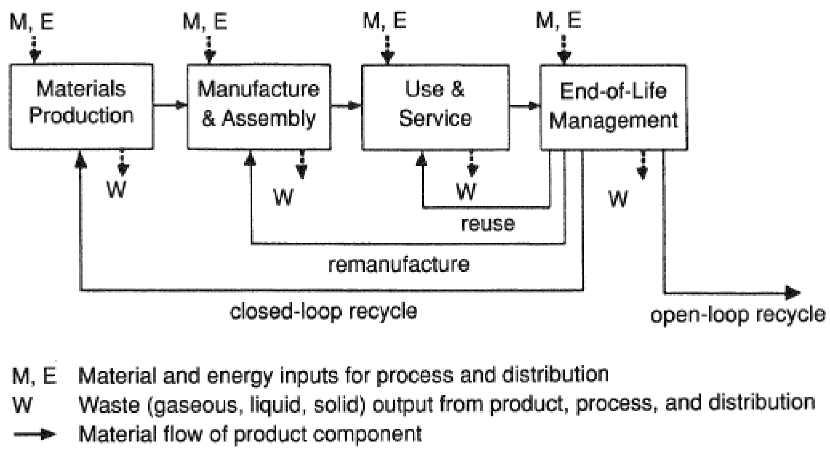


Figure 11: General Products Life Cycle System (Adopted from Keoleian et al. (1997))

At the dismantling stage, reusable parts are first separated and marketed (Go, Wahab, Rahman, Ramli, & Azhari, 2011), hazardous materials are equally separated and treated appropriately, while the remaining hulks are prepared for shredding or other processes. The useable parts may sometimes be refurbished before they are utilised. At the shredding stage, hazardous materials are further screened, and then separated into ferrous and non-ferrous components using magnetic processes. The materials are thereafter subjected to the air separation processes, whereby they are segregated according to their weights. All categories of materials are distributed accordingly for the next processes including steel mill, non-ferrous separation facility, or landfill. The remains are referred to as Automobile Shredder Residue (ASR) (Keoleian et al., 1997).

The non-ferrous metals include aluminium, copper, stainless steel, lead, magnesium, zinc, brass, and nickel, and each is sorted using the most appropriate separation method. Knight and Sodhi (2000), identify the commonly used separation techniques as magnetic separation, air separation, Eddy Current Separation, and density separation.

The environmental impacts of vehicle retirement are in the area of waste generation and energy consumption. Approximately 70% of a typical car is iron and steel that can be recovered and may be up to 10 million tons annually. This is a considerable amount with enormous environmental gains, as this will require only one quarter of energy compared to steel made freshly from iron ore, in addition to materials preservations (Keoleian et al., 1997).

An analysis of a composition of a 1984 vehicle reveals that it is 77.9% metal, which has a recovery rate of 95%. This implies that if only metals are recycled, 74% of materials in motor vehicles are recoverable. Nonetheless, selective plastics, coolants, parts of tyres, and engine oil are equally recoverable at the dismantling stage of automobiles. Non-metallic components made up of plastics, rubber, and glass, among others made up the bulk of ASR that may be deposited in the landfill; a trend that is likely to change with the new sustainable designs of automobiles (Keoleian et al., 1997).

There are initiatives for automobile design for recyclability or design for end-of-life, which enshrines simplified mechanical disassembly (Mok, Kim, & Moon, 1997), materials combination, materials' identification and standardisation, replacement of hazardous materials, lower costs, and changes in reclamation techniques (Boothroyd & Alting, 1992; Keoleian et al., 1997). There is a database on materials properties and disassembly instructions developed by a group of vehicle manufacturers called International Dismantling Information System (IDIS) (Hedlund-Åström, Luttropp, & Reinholdsson, 2005). This will be applicable in design for disassembly, design for remanufacturing, and design for recycling (Mayyas et al., 2012, p. 1847). Vehicle Recycling Partnership (VRP), Cooperative Research and Development Agreement (CRADA) are some of the Government and industry initiatives aimed at minimising environmental impacts, improve efficiency, and to provide guidelines and solutions in the automobile industry (Keoleian et al., 1997).

The combined energy consumed in dismantling, shredding, separation, and transportation of retired vehicles is comparatively smaller than other lifecycle phases. According to Mcauley (2003) cited in (Mayyas et al., 2012), more than 87% of the energy consumption of automobiles is in the use stage (Fig 12). Dismantling involves more of manual than mechanical labour, whereas energy consumption in shredding stages is proportional to the quantity of the materials processed, which ranges between 66-170 Kj/Kg. More energy is consumed in materials transportation from one process to another than dismantling and shredding, and may be up to 678 Kj/Kg per automobile (Keoleian et al., 1997).

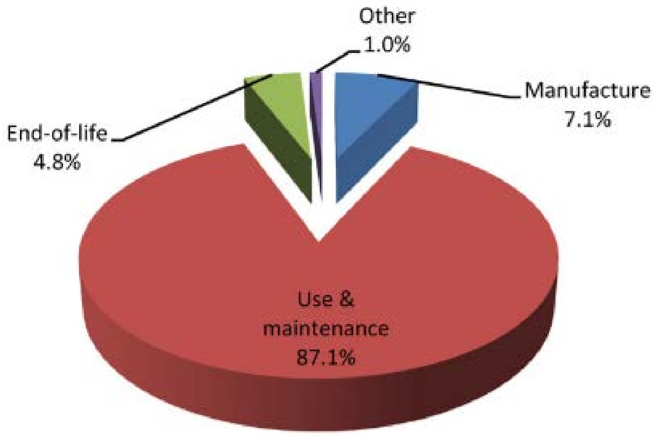


Figure 12 Energy Consumption of Automobiles in different life-cycle stages adopted from Mayyas et al, 2012.

People may retire automobiles for degraded performance, structural damage, and unavailability of components. While in some countries, like the US, dismantlers acquire retired vehicles at a cost, in other countries more especially in Europe, owners pay to dispose retired vehicles. Alternatively, the liability for retired vehicles may be placed on the Original Equipment Manufacturer (OEM), or suppliers (Keoleian et al., 1997; Zarei, Mansour, Hosseinzadeh Kashan, & Karimi, 2010). Automobiles consist of some electronics; in such circumstances therefore manufacturers may be compelled by law to re-acquire their products by the end of their life in the European Union, Japan, USA, and Australia as an extension of the polluter pays principle (Go et al., 2011; Olivetti, Gregory, & Kirchain, 2008); and it was reported that manufacturers have been embracing environmental issues into their operations including supplies (Koplin, Seuring, & Mesterharm, 2007). The process of backward flows of raw materials from end-user to manufacturer is termed as the reverse logistics (Cruz-Rivera & Ertel, 2009; Ferguson & Browne, 2001). There are writings on the economic implications of reverse logistics, such as how it affects cash flows and its impacts on production (Wilcox, Horvath, Griffis, & Autry, 2011), and its application as a sustainable tool for purchasing raw materials (García-Rodríguez, Castilla-Gutiérrez, &

Bustos-Flores, 2013). However, details and its specific impacts on the automobiles industry is subject of other studies.

The profitability of different categories of recycling enterprises is a function of the ratio of recyclables in the vehicles components. Another significant factor that may affect profitability is the landfill disposal cost, which differs between countries. This is usually higher in European countries where ASR is considered as hazardous material. Each of the dismantlers, shredders, or non-ferrous processors shares in the transportation and processing cost of the automobile materials (Keoleian et al., 1997).

The building deconstruction process can be improved by borrowing ideas from the automobile industry in different ways. First, the dismantling, shredding, and materials separation stages in recycling of automobiles is a good process model for the end-of-life management of structures in the built environment. Secondly, the separation and marketing of reusable parts is another credit of the automobile worthy of emulation in the construction industry. Thirdly, the special treatment given to hazardous materials at the dismantling stage of automobiles can be adopted in the decommissioning of building structures.

Moreover, while design for deconstruction is not a new concept in construction (Chilton, 2009), some of the initiatives for automobile design for end-of-life are worthy of emulation. These include simplified mechanical disassembly (Mok et al., 1997), materials combination, materials' identification and standardisation, replacement of hazardous materials, lower costs, and changes in reclamation techniques (Boothroyd & Alting, 1992; Keoleian et al., 1997). The development of construction materials properties database and disassembly instructions resembling the IDIS can be considered for transfer to the construction industry.

The aircraft is yet another sector that may potentially influences the construction industry from ecologically friendly practices in the end-of-life management and materials recovery.

3.3 Can construction learn from End-of-life management of Aircrafts?

Airbus and Boeing respectively estimated that within the period 2009-2028, 8453 and 12200 aircrafts will be retired; moreover, by the year 2009 an estimated 4691 commercial aircrafts were reported to be out of service worldwide (van Heerden & Curran, 2011). When out of service, aircrafts are kept in boneyards. Aircraft boneyards emerged as a clear indication of the rapid development of both military and civilian aircraft in the beginning of the 20th century. While providing the natural destination for the massive aircrafts employed for the first time in the world-war II (Weeks III, 2009), the boneyards once offer more economically attractive dumping site for airlines, even if it is for maintaining financial status and bookkeeping purposes (Carberry, 2008). The volume of aircrafts in a boneyard at a time can be very large; it has been illustrated that the dynamics of aircraft passenger market, technological or regulatory changes, influence the volume of planes parked in boneyards (Weeks III, 2009).

In the deserts of the United States, where climatic conditions are more favourable to the preservation of the body parts, not less than 20 such yards were identified. The first massive retirement of aircrafts was after the WWII and from late 1960s when the military and passenger aircrafts technology shifted to jet engines. Many aircrafts were temporarily retired in 1974 to 1980, and in 1991 caused by instability in the oil market and the gulf war. The 9/11 attack and the lingering economic crises from 2007 is another season for the large volume of aircrafts in the desert (Weeks III, 2009). Similarly, on the construction front, there is equally an established correlation between the economy of a country and construction activities (LOPES, 1997), which include demolition.

Planes may be recalled back to service in good economic times and sometimes reused as Cargo planes or exported to other countries (Weeks III, 2009), which is a more sustainable practice implying that aircrafts are sometimes only suspended from service temporarily. Storage is the major distinguishing feature of the aircraft end-of-life management, a reason that makes the US military sometimes use *“Spraylat”* plastic coating to preserve the body of aircrafts for possible future reuse or export (Weeks III, 2009). Comparatively, the possibility of buildings to be suspended from service temporarily and to be re-engaged at a later stage is a subject of another inquiry.

The destiny of retired aircrafts in the other parts of the world may not be very much different from the American scenario, which is another testimony to the enormous waste that characterised the technological progress of humanity (Goodland & Daly, 1996). Nevertheless, the current pressure for change to more sustainable practices cannot spare any sector (Brandon & Lombardi, 2011; Brundtland, 1987), including aviation, even though relatively negligible compared to other sectors (Airbus, 2008). It is therefore not surprising that the duopoly competition in the aviation sector between Airbus and Boeing is reflected in their efforts to comply with regulatory as well as ethical requirements for sustainable practices. While Airbus established a joint venture to manage retired aircrafts using a demonstration project called “*The Process for the Advanced management of End of Life of Aircraft*” abbreviated as PAMELA (Costes, 2007); Boeing on the other hand promote the formation of a professional group of aircraft scrapping specialist companies named-Aircraft Fleet Recycling Association (AFRA) (AFRA, 2009).

The Airbus PAMELA-LIFE demonstration project, supported by the EU, proves the possibility of reusing, or recycling 85% of an aircraft. The

Airbus-Aerosave joint venture adopted the methods evolved in the PAMELA-LIFE project to sustainably retire aircrafts as well as generate data for future designs. There is an established centre for the scrapping operations of the Airbus aircrafts at Tarbes airport in France with minimum waste and a claim for total adaptation of the *"cradle-to-cradle"* paradigm. Aerosave claims to have provided an alternative to the unsustainable and sometimes illegal dumping of aircrafts at desert airports by achieving 90% recovery by weight. The recovery activities of Aerosave include engine and airframe recycling; and component removal, packaging, storage, and shipment. In this model, the original manufacturers largely assume responsibility for the end-of-life management of products through partnership venture. This is however in contrast to the business model adopted by the Airbus' rival- Boeing, claiming to be a response to the quest of the operators (Airbus, 2008; Carberry, 2008).

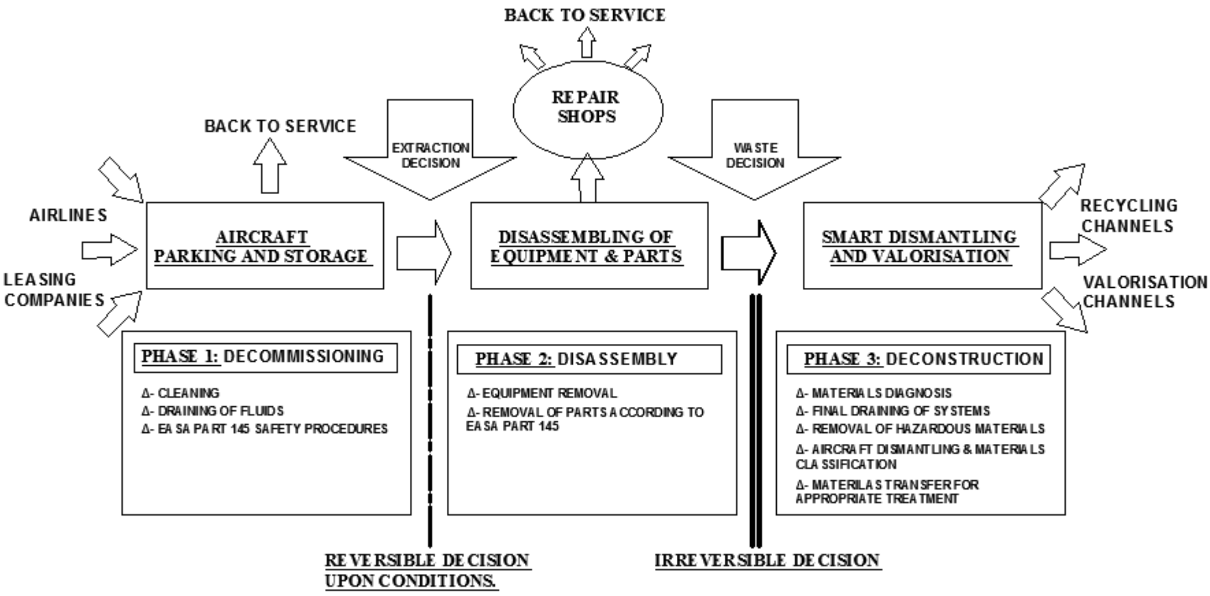


Figure 13: AIRBUS *"3D MODEL"* OF AIRCRAFT END-OF-LIFE MANAGEMENT (Airbus, 2008)

As an outcome of a survey of enterprises that specialise in aircraft end-of-use management in 2006, a professional association was formed with Boeing being the facilitator and an associate member (Boeing, 2007). The

Aircraft Fleet Recycling Association - AFRA - adopted an agenda to evolve a code of conduct, standards and exchange best practices techniques among members, however, compliance with the standards is optional (AFRA, 2009). The recycling activities of aircrafts engaged by AFRA members include mechanical and chemical processes of composite materials recycling, fibre recovery, aluminium sorting, electronics recycling, economic use of labour and energy, while disposing only the unavoidable wastes (Boeing, 2007). The objective of Boing (Fig 14), is to achieve 90% to 95% recyclability of both military and civilian aircrafts by 2016 (Boeing, 2013), and AFRA accredited centres are involved in the recertification and reuse of second-hand parts (Carberry, 2008).

PHASE ONE (STANDARDISATION)	a. Standardised Definition of Terms
	b. Standardised BMP System Requirements
PHASE TWO (FACILITY)	a. Standard Operations Site/Location
	b. Security for operations and storage
	c. Area for special operations
	d. Inventory Accounting & Audits
PHASE THREE (TRAINING)	a. Training of Personnel to perform Operations
PHASE FOUR (DOCUMENTATION AND RECORDS)	a. Asset and Transaction Records
	b. Reference Manual for Disassembly
	c. Identification and Tagging
	d. Parts Stocks and Fate
PHASE FIVE (TOOLING)	a. Use of Appropriate Tools
	b. Maintenance and Testing of Tools
PHASE SIX (HANDLING OF PARTS)	a.Screening and Tagging
	b. Packaging
	c. Transportation
PHASE SEVEN (RECYCLING)	a. Environmental Protection in Operations
	b. Identification of items for recycling
	c. Selection of recycling procedure and facility
	d. Monitoring Recycling Operations
	e. Implementation of Recycling Agreement
	f. Appropriate Management of Fluid Contents

Figure 14: AFRA Best Management Practice of Retired Aircrafts (AFRA, 2009)

Nevertheless, it is not only AFRA that advocates the reuse of aeroplanes, as was reported by the CNN Kim (2013), there are many creative ways retired airplanes are used around the world. These include furniture, hotels, museums, private homes, boats, bars, floor and wall tiles, artificial reefs and bags. The Costa-Rican hotel Costa Verde is one of the most famous airplane hotels. Other examples of hotels built from retired aeroplane are the *"hotelsuites* NL" in the Netherland (Weeks, 2013), airbnb in the Netherlands, Lioba Schneider/Jumbo Stay in Sweden, etc (Thompson, 2012). Motorart is a company that is famous in making furniture from retired aircrafts, while Skypak makes trolleys (Kim, 2013). These examples indicate the extents by which aircrafts are adopted for other purposes at the end of their service life. If this lesson is to be transferred to the construction industry, than a deconstructed steel floor for instance may be used to fabricate a door or window.

On the other hand, the aviation industry is a good example for the practice of the complete producer responsibility for the end-of-life management of a product. This is represented by the development and application of comprehensive decommissioning processes by the duopoly rivals, Airbus and Boeing, as discussed above. Nevertheless, the relatively longer lifecycle of buildings may make producer responsibility practice in the construction sector more challenging. The different applications that retired aircrafts assumed is hitherto another good ecologically friendly practice from third party initiative that can be adopted in the construction industry.

3.4 Treating Buildings as ships at the End of lifecycle

While ships are locomotives, buildings are usually fixed to one location; however, the two have as many features in common as at variance. The end-of-life disassembly processes of ships is usually labour intensive courtesy of its large size (Hedlund-Åström et al., 2005), a common feature of building structures too. In the disassembly process of ships there may be an encounter with hazardous contents that mandated detailed labelling (Hedlund-Åström et al., 2005), a requirement that may be necessary in the case of buildings with hazardous contents (Sassi, 2008). According to the International Maritime Organisation - IMO, ships should carry and maintain installed materials property labels throughout their lifecycle (Gramann H., Krapp R., & Bertram V., 2009), however, there is no evidence to suggest that this requirement is prescribed anywhere for buildings.

Innovative use of new materials like polymer composite materials is another trend in the ship design (Hedlund-Åström et al., 2005), which is a pattern that can equally be observed in the construction sector. The end-of-life management of such composite materials is usually associated with challenges, such as expensive recycling costs, and lack of market for the recycled products (Hedlund-Åström et al., 2005). It is worthy to note that efforts are under way to tackle these challenges through researches. One of such researches for instance, was about the utilisation of blast grits from shipyards in the production of bitumen (Buruiana, Bordei, Sandu, Chirculescu, & Sandu, 2013).

The researches into more effective ways to handle difficult materials may probably be motivated by legislations such as the Extended Producer Responsibility, the EU Directive for End of Life Vehicle (ELV), Directive for the Reduction of Hazardous Substances (RoHS), and Landfill Regulations (Hedlund-Åström et al., 2005). Identification of the material property of each component is very essential in the process of ship dismantling, irrespective of the method applied for its end-of-life treatment. All materials should be labelled appropriately using the conventional waste information model, like the International Dismantling Information System (IDIS), developed by a group of vehicle producers. The segregation should be repeated in each of the four stages of dismantling, cutting, shredding, and grinding (Hedlund-Åström et al., 2005). On the other hand, the construction sector equivalent of the IDIS is yet to be promulgated.

The Technical Committee ISO/TC 8, "*Ships and marine technology*" of the International Standards Organisation-ISO developed the ISO 30004 to address the industry wide quest for recycling standards. This is further mandated by the undesirable practices in the sector that threaten human health and safety, and the environment. A flexible model that provides the minimum benchmark with flexibility for appropriate response to the varying factors within or external to an establishment, is therefore a welcome development (BS30004:2012, 2012).

According to the BS30004:2012 (2012), ship recycling is one of such activities that requires constant revision and updates, whereby, the *"Plan-Do-Check-Act"* (PDCA) management system, sometimes referred to as *Demming Wheel* or *Shewhart Cycle* (Lee, 2002), is recommended as a generic model. In this approach, the top management control activities through strategic planning, implementation, monitoring, and review. At the planning stage, the recycling targets and methods for achieving the targets are established. The implementation phase will require management structures with clearly defined roles, availability of resources including personnel, processes, documentation, and control. The check stage will involve monitoring, evaluation, audit, and adjustments. And finally in the action phase, there will be the need for revision and updating of the entire management approach (BS30004:2012, 2012).

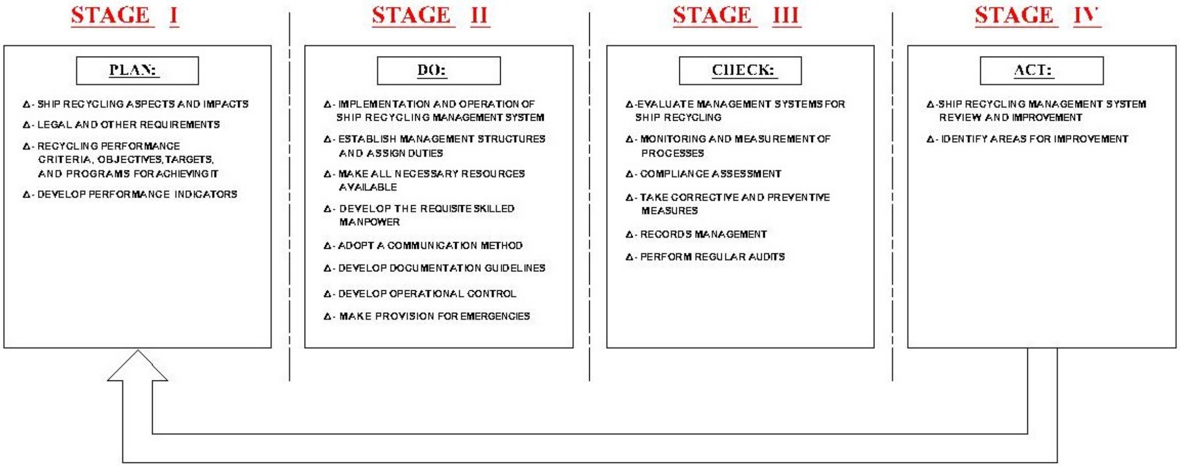


Figure 15: Generic Ship Recycling Management Model adopted from ISO 30004 (BS30004:2012, 2012)

The commitment and leadership of the high-level management of an organisation is identified as the key to successful ship recycling program. The management of an organisation should plan, execute, control, and review a ship recycling policy that entails the level of safety, health, welfare, and environmental targets to be achieved. This will involve defining the scope of the ship recycling management system for effective control of processes and procedures. All the safety and welfare, and environmental aspects, among other activities within the defined scope should be assessed against ISO 30000. Clear and measurable performance indicators should be established by an organisation (BS30004:2012, 2012).

In the ship recycling industry, activities related to safety, welfare, and environment are referred to as *"ship recycling aspects"*, while the favourable or unfavourable variations due to the ship recycling aspects are referred to as *"ship recycling impacts"*. An organisation is expected to identify and define its approach to both the ship recycling aspects and impacts. There are much legislations, international, national and local that affects ship recycling, which an organisation is required to be up-to-date and compliant. All these requirements will require appropriate human, physical, and financial resources; as well as proper management of these resources. The management should create competent and make aware employees through training and good internal and external communication practices (BS30004:2012, 2012). Additional responsibilities of the management include proper documentation and control of documents, operational control, emergency preparedness and response, evaluating and monitoring ship recycling performances, and taking corrective and preventive actions. Others are regular audits and reviews, and constant improvements (BS30004:2012, 2012).

The first feature of the ship recycling industry is the adaptation of materials property information labels; and the second feature is the challenges of the composite materials. The third feature is the International Standards organisation (ISO 30000) ship recycling management system. The ISO 30000 adopts the PCDA management system, which endorse setting recycling targets and methods of achieving them, and establishing management structures with defined roles. The ISO further recommends making available all necessary resources, as well as documentation. Other recommendations of the ISO are monitoring and evaluation, auditing, updates and revisions. Nevertheless, all these features are either similar or desirable for the construction industry.

While the challenges for composite materials may be similar for the construction sector, materials property information label is very desirable for the construction industry. The PCDA management approach on the other hand, may not be an unknown system in the construction sector (Lee, 2002), however, its application for the development of an industry wide and international standard in the like of ISO 30004 or BS 30004 is yet not available in the construction sector.

The most important lessons to learn from the ship industry are the ISO 30004 ship recycling management model and the IMO requirement for ships to carry and maintain installed materials property labels throughout their lifecycle. If this idea is transferred to the construction industry, buildings should be requested to carry and maintain materials property labels throughout its life cycle. The emphasis of the ISO 30004 on the role of the top-level management of organisations in the end-of-life management should be noted, especially as a lesson for the construction industry.

While dissimilar to the construction industry, the cell phones may be another source of lesson for the construction industry in material recovery at the end-of service of products.

3.5 A Comparative Analysis of Cell phones Reuse and Recycling and the Nigerian C&D Salvage Market.

The business models and drivers for reuse and recycling operations of cell phones in the UK and US suggest that end-of-use products are being reused more than recycled, a likely feature of the Nigerian construction industry. Notwithstanding take-back programs of some Original Equipment Manufacturers (OEM) (Apple, 2013; Nokia, 2013), a study of the cell phone lifecycle conducted in 2003 in the UK and 2006 in the US by Geyer and Doctori Blass (2010), discusses third party enterprises responsible for the reverse logistics, reuse and recycling operations in the two countries. Ongondo and Williams (2011b) corroborated the significance of this type of enterprises in phone take-backs, by reporting that an estimated 83% of the voluntary phone take-back schemes in the UK may be profit oriented enterprises. These third party operators in the cell phone sectors may be comparable in many respects to the operators of the salvaged building products market in the Nigerian construction industry.

This type of enterprises is central to the reverse logistics, reuse and recycling of cell phones rather than the manufacturers; similarly, the salvaged products marketers are the major promoters of reuse and recycling in the Nigerian construction sector. It was suggested that manufacturers may not be in favour of these types of businesses for fear of cannibalisation or displaced production that might be associated to this type of enterprises; however, there are counter arguments that suggest otherwise. It was further discovered that displaced production may be the most important environmental advantage of cell phone reuse and recycling (Geyer & Doctori Blass, 2010).

The decommissioning, collection, and recycling or reuse of cell phones may also share some similarities with what is obtainable in the construction sector. While many salvaged building materials may be the by-product of renovations and remodelling, Saphores, et al (2006), Meyers et al (2002), and Coopers and Meyers (2000) in Geyer and Doctori Blass (2010) identify upgrade to newer models as the major reasons for discharging handsets, which also results in shorter lifespan as well as market growth (Paiano, Lagioia, & Cataldo, 2013).

The end-of-use handsets collection method is usually achieved through mass collection such as drop-off bins and return incentives such as prepaid envelopes, prize draws, or buy-backs (Geyer & Doctori Blass, 2010; Ongondo & Williams, 2011b). Salvaged building materials in Nigeria are likely being recovered from bins or buy-backs; which will be verified in chapters 5 and 6 from the analysis of the data collected from fieldwork. Phones that are suitable for reuse receive minimum reprocessing as salvaged building materials are treated (Geyer & Doctori Blass, 2010).

The environmental benefits of cell phones recycling are usually accomplished through materials components recovery and improvement of secondary material quality (Scharnhorst, Althaus, Classen, Jolliet, & Hilty, 2005), a trend that is probably reflected in the C&D salvage market of Nigeria. On the other hand, it was reported that 65% of cell phones are reused in US (Geyer R, 2004), and over 50% in the UK (Doctori Blass et al, 2006), higher proportion of salvaged building products may be reused in Nigeria.

The EU Waste Electronic and Electrical Equipment- WEEE Directive, California's Assembly Bill AB 2901, and UN environmental program's Basel convention are example of legislations that may affect the reuse and recycle operations of cell phones; however, there may be no sector specific legislations for both cell phones reuse and recycling, as for the C&D salvage market in Nigeria. The two are driven more by profitability than legislation. Incomes are generated through sales of the refurbished cell phones or recovered metals (Geyer & Doctori Blass, 2010). Although, the general small WEEE collection targets are not attained (Polák & Drápalová, 2012), only 9% of mobile devices are returned for recycling (Nokia, 2013). In a 2012 research survey in the US, it was realised that convenience, toxicity awareness, recycling experience, gender and marital status (Saphores, Ogunseitan, & Shapiro, 2012), and sometimes monetary incentives (Ongondo & Williams, 2011a), are the most significant factors in determining the willingness of household to re-cycle e-waste including phones. The absence of solid waste management infrastructures affects cell phones recycling efforts in Nigeria (Nnorom & Osibanjo, 2008), a challenge that may be extended to the C&D waste as a common characteristics of developing countries (Ongondo, Williams, & Cherrett, 2011, p. 726).

The similarities highlighted above notwithstanding, the reuse and recycling of cell phones possesses some distinct features that differentiate it from the construction sector. Unlike construction sector, due to their small sizes, many phones may pass through landfills unnoticed (Geyer & Doctori Blass, 2010), and when accounted for, may only be 6-10% of the total solid waste (Sha'Ato et al., 2007).

The demand for reusable handsets may be market driven as with salvaged building products in Nigeria; furthermore, there are reports of significantly higher demand for reusable handsets than the supply. The ratio of the demand to supply of salvaged building products in Nigeria is however, subject to verifications. While the universal negative attitude of consumers to take-back programs is worrisome (Jang & Kim, 2010; Lim & Schoenung, 2010), a time lag between retiring of handsets and actual disposal can sometimes be critical as the secondary market value of the handsets declines with time (Geyer & Doctori Blass, 2010). According to Nokia (2013), there are findings that only 56% of unutilised cell phones are disposed by owners, while only 9% are made available for recycling. In a survey among UK university students, an estimated 3.7 million handsets or 60% of retired phones are accumulated by students (Ongondo & Williams, 2011a). This trend is subject to further investigation in the Nigerian C&D sector.

The concurrence of reuse and recycling markets for phones suggests profitability in both instances. The profit margin can be evaluated as the difference between the selling price and the cost of the reverse logistics. This covers the cost of attracting returns, collection, shipping, inspection, sorting, and sometimes refurbishment. Reverse logistics cost varies greatly depending on the collecting agent's business orientation. It is documented that the reverse logistics for electronics including handsets can cost up to 80% of the retiring management expenses (Geyer & Doctori Blass, 2010). The reverse logistics for the Nigerian C&D salvaged products may follow the same pattern as the cell phones; however, this is subject to further investigation and the outcomes of the data (see chapters 5&6).

On the other hand, the management of cell phones designated for recycling may be different from the cell phones designated for reuse. Cell phones can be 100% recycled (Nokia, 2013), however incomes are realised from the sales of recovered materials with very negligible profit margin (Darby & Obara, 2005, p. 33; Geyer & Doctori Blass, 2010). According to the survey conducted by Geyer and Doctori Blass (2010), it was concluded that cell phone recycling can only be profitable without the cost of the reverse logistics. In the same survey, it was conversely discovered that reuse is always profitable even with the cost of reverse logistics inclusive, with more than 50% yield. The comparative analysis of profitability between recycling and reuse in the Nigerian C&D salvaged products is another area yet to be explored.

The main positive feature of the end-of-life management of cell phones is that, it is driven more by profitability rather than legislation. The existence of third party enterprises that handle the reverse logistics at a profit should be encouraged in other sectors, including construction. However, the activities of these enterprises may be contrary to the spirit of the Extended Producer Responsibility legislation.

A selective adaptation of the end-of-use handsets collection methods such as drop-off bins, return incentives, buy-backs, etc may possibly be copied in the construction sector. Additionally, the sizes of the construction materials will make it unsuitable for hoarding by the original owners, as in the case of cell phones.

The nuclear sector on the other hand is as unique as the construction sector. In the following section the feasibility of exchanging best practices between the two sectors will be explored.

3.6 Can the Construction Sector Learn from the Nuclear Decommissioning Practices?

According to the International Atomic Energy Agency IAEA (2006), nuclear facilities may need to be decommissioned at the end of a research program, when the technology becomes obsolete, or due to policy change. Other reasons for withdrawing nuclear facility from service include economic factors and for safety and health concerns, leading to many retired nuclear facilities. The number of decommissioned nuclear facilities worldwide therefore qualifies it as a model for the study of end-of-life management in general and for the built environment in particular.

While the hazards associated with handling nuclear facilities may not be comparable with many other sectors, the experience acquired makes it a valuable asset worthy of study. This can be in the areas of health and safety, techniques, equipment, methods and costs. Moreover, nuclear plants belong to the category of infrastructure designed *ab initio* with a predetermined lifespan, which makes a withdrawal plan very crucial (Joint US/Russian Study Team, 1998). Decommissioning plans and updating the plans is part of the mandatory requirements for issuing nuclear operation licence (UNEP, 2012). Equally, buildings can be designed with predetermined lifespan, and incorporating decommissioning plans as part of the requirements for building permit may be desirable.

Accident in the nuclear sector makes safety issues much more essential (UNEP, 2012). These issues include construction quality, operations and maintenance, reliability of equipment, and emergency preparation (Holt, 2009). An assessment of human and environmental hazards associated with nuclear decommissioning and mitigation plans are requirements of the IAEA safety standards. Every task in the process of decommissioning should be evaluated in terms of the environmental and human hazards, a detailed management plan should be in place as early as possible. The safety and precaution plans should cover workers and the public, during and after the operations. Additionally, the management of the waste to emerge from the decommissioning activities should be planned beforehand (International Atomic Energy Agency IAEA, 1999). While the requirement for waste management plan is an existing regulation for construction works in the UK (Osmani, 2012), however, the detailed health and hazards precautionary and mitigation plans specific to building decommissioning will need to be developed.

The IAEA, gives three ways by which nuclear facilities can be deconstructed - immediate dismantling, deferred dismantling (safe enclosure), or entombment (International Atomic Energy Agency IAEA, 1999; UNEP, 2012). In the US, the immediate dismantling method is called “DECON”, while the deferred dismantling is referred to “SAFSTOR” (Joint US/Russian Study Team, 1998). Entombment is a method whereby the nuclear reactors are enclosed with a membrane usually concrete for long period until it is safe (Joint US/Russian Study Team, 1998; UNEP, 2012), an action not needed in the building sector. However, the DECON and SAFSTOR methods may be recommended for buildings decommissioning depending on the circumstances. Prompt dismantling of buildings may be justified if there is an emergency that threatens safety and health, like in the case of accident or risk of damage to neighbouring buildings. Nevertheless, the gradual processes of the SAFSTOR are likely to be more in line with the principles of sustainability.

The first stage of SAFSTOR involves withdrawal from service, suspension of all active services (electrical, mechanical, etc), and removal of all hazardous and useful materials (Joint US/Russian Study Team, 1998). In the nuclear sector, this stage may take up to five years, however, for buildings, the procedures may be adopted with all the advantages realised in shorter period. Stage 2 entails partial restrictions of access and usage of the facility including restriction of access to the hazardous zone. In the same vein, this stage can be emulated by the building sector, whereby partial access is permitted to salvage all useful items. Stage 3 is the final removal of the facility to allow unrestricted use of the land for the same or any other purpose. While the time taken to complete stage 1 to 3 for nuclear facilities may take 5 to 135 years depending on location and circumstances (Joint US/Russian Study Team, 1998), the benefits of the processes can be realised in the building sector within a relatively shorter period as indicated in table 1.

Table 1: LESSONS FROM "SAFSTOR" NUCLEAR DECOMMISSIONING PROCESS

	SAFSTOR NUCLEAR DECOMMISSIONING PROCESS	LESSONS FOR BUILDING DECOMMISSIONING
STAGE I	Officially, shutdown, fuel and fluids removed, and operating system disconnected. Restricted access only for safety purposes	Decision to retire building, disconnection from services, Restricted access for removal of all useful and moveable items
STAGE II	Limited access, and use of the site. Only hazardous areas are restricted.	Unlimited but careful removal of all materials that may be useful without compromising the structural stability of the building
STAGE III	Final removal to allow unrestricted use of the nuclear facility	Final removal to allow unrestricted use of the building

The responsibility for the nuclear decommissioning was transferred to the utilities from the US Nuclear Regulatory Commission (NRC), however, there are several NRC rules regarding decommissioning. Other requirements are Occupational Safety and Health administration (OSHA), and National Environmental Policy Act (NEPA). While programs like OSHA and NEPA are generic in nature, the NRC rules are specific to the nuclear sector (Joint US/Russian Study Team, 1998). The equivalent of these policies specific to the construction sector in the UK is the expunged Site Waste Management Plan (SWMP) Regulation that was not specific to decommissioning. This implies the potentials for improvements in the building decommissioning sector.

In the nuclear sector, the cost associated with decommissioning is usually very significant (3-5%) and financial plans become crucial. Depositing money in a dedicated account before commencing operations sometimes finances nuclear facility decommissioning. Alternatively, certain part of the electricity tariff is continuously saved into a dedicated account for the decommissioning operations. The other method is the surety fund, letter of credit or insurance policy for the nuclear facility (Joint US/Russian Study Team, 1998). The three methods of financing nuclear decommissioning can be adopted when retiring buildings that may require significant funding. Nevertheless, it is believed that retiring buildings if managed properly may be self-funding or even generate profit.

While the radioactive waste is managed at the global level, with a conventions ratified by 62 countries (UNEP, 2012); there is the OECD/NEA international collaboration program launched in 1985 - International Cooperative Program for the Exchange of Scientific and Technical Information Concerning Nuclear Installation Decommissioning Projects. The purpose of this program is to share knowledge and experience of nuclear decommissioning among member states. Some of the areas covered by the program include assessment methods, cutting techniques, remote operations, waste management, health, and safety (Joint US/Russian Study Team, 1998; Nuclear Energy Agency NEA, 2013). There may be International Cooperative Programs for the Exchange of Scientific and Technical Information Concerning buildings, however, not in the same scale and specific to decommissioning as in the nuclear sector.

Furthermore, specialised equipment and technologies including remote operations, equipment for handling radioactive liquid or solid waste, among others have been developed for nuclear facilities decommissioning purposes (Joint US/Russian Study Team, 1998). One of the approaches to nuclear facility decommissioning is the installation of waste processing plants on site. Equally, in the construction sector there is the need for specialised bespoke equipment and technology that is different from the conventional tools, which will make dismantling of buildings more sustainable. The personnel, method, and organisation of activities in nuclear facility dismantling is usually determined by the assigned time frame (Joint US/Russian Study Team, 1998). This can logically be applicable to the construction, and any other sector, as generally the faster a task is required to be completed the more personnel, or equipment will be needed. Nevertheless, the organisation of activities in the nuclear decommissioning can provide a good lesson for other sectors. The dismantling tasks are categorised into different groups such as hazards, or technical classification.

The International Atomic Energy Agency IAEA (2006), gives an outline of the nuclear decommissioning process as six major groups of processes. This includes withdrawal from active service, removal of radioactive substances, and decontamination and cleaning. Others are dismantling of structures, waste management, and unrestricted release of site. Each of these six processes of the nuclear decommissioning can have a matching corresponding process in the building decommissioning as indicated in Table 2.

Table 2: LESSONS FROM INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA) GENERAL NUCLEAR DECOMMISSIONING PROCESS.

	IAEA NUCLEAR DECOMMISSIONING PROCESS	**LESSONS FOR BUILDING DECOMMISSIONING**
STEP I	Withdrawal from active service	Decision to retire building, and all usages come to stop including utilities supply
STEP II	Removal of Radioactive substances	Removal of all hazardous substances
STEP III	Decontamination and cleaning	Salvage of materials, fittings and fixtures
STEP IV	Dismantling of structures	Dismantling of structures
STEP V	Waste Management	Waste Management
STEP VI	Unrestricted release of site	Unrestricted release of site

The construction industry can learn from the nuclear sector the tradition of designing nuclear plants with pre-determined lifespan as part of the requirements for building permits. This may include decommissioning plans and updating the plans as part of the mandatory requirements for issuing construction licence, similar to the nuclear sector.

The IAEA three methods of nuclear facilities deconstruction may not be directly applicable to other industries; however, the detailed process mapping as in the foregoing discussion can be emulated in the construction industry. Similarly, the methods for financing nuclear sector decommissioning may be applicable in the construction sectors, where the demolition costs become significant. Nevertheless, in building demolition projects where the decommissioning cost is insignificant, self-financed, or even profitable, such a plan may not be necessary. The health and safety precautions adopted in the nuclear sector may be transferable to construction more especially regarding hazardous materials. However, the type of material to be handled becomes very critical in deciding the most appropriate handling method.

Whilst in the foregoing sections different sectors were evaluated for lessons to be transferred to the construction, the next section is about inspirations from the Mother Nature on the best approach for managing materials at the end-of service.

3.7 Natural Ecological Systems

In the setup of the natural ecological systems, while they forage on the plants, the herbivores supply food to the different layers of carnivores. For instance, the insectivorous birds, mammals, or insects like the blackbird, hedgehog, spider, are usually consume by some classification of birds. The birds are eventually eaten as well by higher carnivores like the birds or beasts of prey (Polis & Strong, 1996).

As the predator-prey relationship continues, all the animals discharge dungs as unwanted material from its body, nonetheless this may not, by all definitions be considered as wastes, but nourishments for plants and another group of animals including the dung beetles and dung flies among other dipterous insects. The carrion left behind by the dead animals is also a ready-made diet for different yet another group of animals ranging from the big to the small ones like sexton beetles and larvae scavengers. While the scavengers may be patient to wait for a natural death, several ectoparasites and endoparasites (ticks, mites, fleas, etc) survive on other animals even against their wish (Bishop, 1973, p. 15).

The important lesson to learn from the natural ecological systems is the existence and interdependence between different species, which eliminates the concept of waste. The waste produced by one specie provides nourishment for another, which is the inspiration for human industrial relationships called industrial ecology; whereby the by-product from one industrial process serves as a raw material for another (Frosch, 1992; Odum, 1977, 1983, 1993).

Organising human industrial activities in the fashion of the natural ecological system termed industrial ecology is one of the many concepts of getting inspiration from nature to develop sustainable solutions to challenges facing humanity collectively referred to as Biomimicry.

The renowned proponent of *"Biomimicry"* (Benyus, 1997), defined it as a science of imitating the designs and processes of nature to solve human problems, while using ecological standards for the judgement of human innovations. According to this paradigm, nature is regarded as a teacher to learn from rather than a source of resources for extraction. The need for such approaches as *Biomimicry* becomes even more compelling as humans realised that our industrial activities is at the threshold of over-stretching the bearing capacity of the planet- earth. The biomimicry enthusiasts are confident about its potentials in providing solutions that one was reported to remark:

"Between now and 2050 I think biomimicry is going to be one of the main tools that will facilitate the transition from the industrial age to the ecological age of mankind…"

Peter Head in (Pawlyn, 2011)

On the other hand, extraction of materials for industrial application is usually associated with negative environmental impacts, and depletion of high quality resources. This trend threatens the same opportunity for future generations as the limited and most useful resources are converted to wastes as discussed in sections 2.3 and 2.4.

On the contrary, it is realised that other living organisms have virtually recorded as much achievements as humans without depleting the natural resources, or poisoning the environment to the extents of threatening their future; achievements that are worthy of emulation by humans (Benyus, 1997; Pawlyn, 2011, p. 1). Beyond the Wright Brothers' mimicry of the birds flying techniques, there is a long list of successful imitation of nature to solve human problems more sustainably in engineering, industrial design, fashion design, and medicine. This includes a solar cell modelled after leaves, a spider-style woven fibre, ceramics inspired by mother-of-pearl, cancer cures learned from chimpanzees, perennial grains in the images of tallgrass, or a computer signals fashioned in the way of the cells (Benyus, 1997).

Biomimicry was the inspiration for developing many concepts in the built environment as documented by (Pawlyn, 2011). An Italian engineer Pier-Luigi Nervi successfully achieved lightweight long-span concrete roof of Palazzeto dello Sport in Rome by imitating the structural principles of the radial rib structure of the leaves of the Amazon water lily. Designed by Frei Otto, the concept of West German Pavilion at the 1967 Expo at

Montreal was inspired by spider webs. Otto made extensive publications on structural principles inspired by nature. Another class of structures inspired by biological principles is the deployable structures that change shapes in response to the external conditions. An example of this type of structures is the retractable umbrellas of the Holy Mosque of the Prophet at Medina in Saudi Arabia and Al-Husayn Mosque in Egypt, designed by Frei Otto's disciple Mahmood Bodo Rasch. Moreover, there are examples of biologically inspired technology for construction materials production, water management, energy production, and thermal control. However, the most relevant to the discourse of this write-up is the creation of a closed-loop economy in the style of the natural ecosystems as in the redwoods, coral reefs, or forests that produce zero wastes (Benyus, 1997; Pawlyn, 2011).

Natural ecological processes use materials in a close-loop cycle, utilize the renewable solar energy, and organise complex communities into niches with adaptation properties. The idea of fashioning human industrial activities to resemble the natural ecological system is the main subject of the concepts of the Industrial Metabolism, Design for the Environment, or the Cleaner Production, and the well-established discipline of Industrial Ecology (Kibert et al., 2000). This concept was accepted with enthusiasm with several conferences and fellowships on the subject, to the extents that it was recognised as the main theme of the National Technology Strategy Policy of Clinton's administration in the US (Benyus, 1997).

While industrial metabolism refers to the use of the waste from one industrial process as a raw material for another industrial process, industrial ecology proposes a situation whereby industries will be interrelated in such a way that not only waste, but also useful energy from one industry can be utilised by another in direct analogy with the natural ecosystem. In the natural ecological food web, there are organisms that specialise in utilising the materials and energy from otherwise the waste of some other organisms. There may be some limitations of this analogy with the human industrial activities; however, human industrial waste can be treated in a similar approach in what is called "Industrial Symbiosis." Nevertheless, Industrial Symbiosis is better achieved if industrial products are designed ab-initio with the environmental agenda; a concept referred to as Design for the Environment (DFE). In a similar manner, minimising pollution, materials and energy throughput in the industrial process while improving the service intensity of products are among the tenets of Eco-Efficiency and Cleaner Production (Allenby, Richards, & National Academy of Engineering., 1994; Kibert et al., 2000).

Industrial ecology on the other hand, as described by Allenby et al. (1994) is teleologically any method of achieving and maintaining the status of sustainable development. In industrial ecology, human economic activities are viewed in terms of their interrelationship with the natural systems with the aim of achieving sustainability. A sustainable manufacturing strategy optimises the complete material life cycle in harmony with the natural systems. On the other hand, Industrial Ecology is a paradigm of making human economic activities to interface with the natural systems by understanding, interpreting, and implementing the principles of the natural systems (Keoleian et al., 1997). The idea of fashioning human industrial systems to simulate and integrated with natural systems in function and interrelationships of producers and consumers started in the early eighties from the works of Odum in the early eighties (Kibert et al., 2000).

A recapitulation of the foregoing reveals that the main theme of industrial ecology and other concepts revolves around materials wastes. On the other hand, the built environment is probably the largest resources consuming sector and could gain the largest proportion of savings by applying the principles of natural systems. As discussed in section 2.7, in the UK alone, an alarming figure of annual 120 million tonnes of waste is generated from construction and demolition (Osmani, 2012), while in the US the figure is about 140 million tonnes annually (one third of total solid waste) (Kibert, 2005). Construction, as the likely highest resource consuming human activity, is always in the mainline of the discussions of sustainable utilisation of resources, such as in the concept of the industrial ecology. Moreover, the peculiar nature of construction industry compared to other industries, qualifies it for a distinctive class (Kibert et al., 2000). *Construction ecology* is therefore an attempt to define a sub-set of the industrial ecology concerned with achieving sustainability in materials manufacture and building construction and demolition by adopting lessons from the natural systems (Kibert et al., 2000).

Unlike manufactured products, every building is in the words of Koskela "one-of-a-kind" product that is different from any other of its type, made up of large quantities and wide range of constituents. Buildings are rather a form of art with enormous environmental impacts, long and uncertain lifespan. On the other hand, the construction industry that produces the buildings is less receptive to innovations and characterised by wide segregation of duties with unsteady workforce. These properties of buildings and the construction industry make quality control more challenging and policies such as the Extended Producer Responsibility (EPR) nearly impossible to implement. Moreover, buildings are made up of composite elements that are not designed for disassembly (Kibert et al., 2000).

While the obstacles to achieving a perfect industrial ecology in the other sectors may be the same with the construction sector, the peculiarities of the latter require a unique approach most appropriate for the achievement of sustainability in this sub-sector. The bespoke concept of Industrial Ecology that is proposed to reposition the construction industry to operate in line with the principles of natural ecology as well as in harmony with the natural environment describe the term *Construction Ecology* (Kibert et al., 2000). The three tenets of Construction Ecology are the close-loop material cycle, the use of renewable energy, and conservation of nature. Buildings that are compliant with the Industrial Ecology paradigm should promote the health of the occupants as well as be suitable for easy deconstruction; and contain materials and components that are durable, adaptable, and friendly to recycling (Kibert et al., 2000).

3.8 Conclusion and Link

When buildings are to be sustainable, more especially in the area of resources consumption, it is imperative to devise an appropriate response in the way resources are utilised. This will require the elimination of the waste generated by construction in general and at the end-of-life of buildings in particular. However, in the search for the best method to achieve this objective, cross-industrial pollination of ideas may provide the much-needed console. Moreover, there are success stories of assimilation of concepts from the manufacturing into construction industry for instance. Examples include the concept of lean construction developed from lean manufacturing (Koskela, 2000), or the concept of construction/industrial ecology developed from the natural ecology (Kibert et al., 2000; Sendzimir & Guy, 2001). It is in consonant with this line of thought that, in this chapter, the end-of-life management of various products across sectors was explored. This includes the automobile industry, aviation sector, ship industry, cell phone industry, the nuclear sector, and the natural ecological system. As opined by Bertelsen (2004), the shortcomings of the construction can be improved by enhancing the process or the product; therefore, in what way can the process or product of construction be improved by learning from other sectors?

The building deconstruction process can be improved by borrowing ideas from the automobile industry in three ways. First, the dismantling, shredding, and materials separation stages in recycling of automobiles is a good process model for the end-of-life management of construction structures. Secondly, the separation and marketing of reusable parts is another credit of the automobile worthy of emulation in the construction industry. Thirdly, the special treatment given to hazardous materials at the dismantling stage of automobiles can be adopted for decommissioning building structures.

Moreover, while design for deconstruction is not a new concept in construction (Chilton, 2009), some of the initiatives for automobile design for end-of-life are worthy of emulation. These include simplified mechanical disassembly (Mok et al., 1997), materials combination, materials' identification and standardisation, replacement of hazardous materials, lower costs, and changes in reclamation techniques (Boothroyd & Alting, 1992; Keoleian et al., 1997). The development of construction materials properties database and disassembly instructions resembling the IDIS should be considered.

On the other hand, the aviation industry is a good example for the practice of the complete producer responsibility for the end-of-life management of a product. This is represented by the development and application of comprehensive decommissioning processes by the duopoly rivals, Airbus and Boeing, as discussed above (section 3.3). Nevertheless, the relatively longer life cycle of buildings may make producer responsibility practice in the construction sector more challenging.

The important lessons to learn from the ship industry are the ISO 30004 ship recycling management model and the IMO requirement for ships to carry and maintain installed materials property labels throughout their life cycle. If this idea is transferred to the construction industry, buildings should be requested to carry and maintain materials property labels throughout their life cycle.

The main positive feature of the end-of-life management of cell phones is that, it is driven more by profitability rather than legislation. The existence of third party enterprises that handle the reverse logistics at a profit should be encouraged in other sectors, including construction. However, the activities of these enterprises may be contrary to the spirit of the Extended Producer Responsibility legislation.

The selective adaptation of the end-of-use handsets collection methods such as drop-off bins, return incentives, buy-backs, may possibly be copied in the construction sector. Additionally, the sizes of the construction materials will make it unsuitable for hoarding by the original owners, as in the case of cell phones.

The Site Waste Management Plan (SWMP) may place the construction industry at the same level with the nuclear sector in terms of end-of-life waste management plan. Nevertheless, the construction industry can learn more lessons from the nuclear sector. The tradition of designing nuclear plants with pre-determined lifespan can become part of the requirements for building permits. This may include decommissioning plans and updating the plans as part of the mandatory requirements for issuing construction licence, similar to the nuclear sector.

The IAEA three methods of nuclear facilities deconstruction may not be directly applicable to other industries; however, the detailed process mapping as in the foregoing discourse (section 3.6) can be emulated. Similarly, the three methods for financing nuclear sector decommissioning may not be required in the other sectors, as the cost is relatively insignificant. In contrast, the decommissioning process in other sectors, including construction, may sometimes be self-financed or even profitable. Nonetheless, where the demolition cost of building becomes significant and the market value of the salvaged materials may not settle the demolition cost, the methods of financing nuclear plants decommissioning may be adopted.

The close-loop material cycle, the use of renewable energy, and conservation characteristics of the natural systems are qualities worthy for transfer to the construction industry.

While the foregoing outlines the best practices in resources management at the end-of-life of products including the natural systems, do these practices have implications in the context of the Nigerian construction industry? The Nigerian practice of the end-of-life management of buildings will be investigated in the light of the outlined best practice in the next sections. Nevertheless, the research design and methodology to be employed in the investigation of the Nigerian practice will be described in the following chapter 4.

Chapter 4 Methodology

"a research design is the logic that links the data to be collected, and the conclusions to be drawn to the initial questions of study. Every empirical study has an implicit, if not explicit, research design. ..."

Robert K. Yin (2009, p. 24)

4.1 Introduction to the Research Method

The logic that connects the data to the research questions is discussed in this chapter. The metaphor of 'onion' after Saunders, Lewis, and Thornhill (2012) was used to organise the important aspects of the research into conceptual layers (Fig 16). The positions adopted in this research were discussed beginning with the philosophical layer, then the ontological, epistemological, and axiological presuppositions. While taking the position of subjectivism ontologically, it was pragmatism and value-laden positions that were taken on epistemology and axiology layers respectively. The research used abductive logic, which implies moving back and forth between inductive and deductive logics. On the quantitative-qualitative divide, this research is going qualitative not as a guiding principle, which was mixed-method, nevertheless as a pragmatic solution for achieving the research objectives. Among the research tools Saunders et al. (2012) identified as strategies, an embedded case study is selected to be employed for this research. As case study strategy uses small size samples, how to select the samples was considered very important and therefore sampling was treated as additional layer particularly vital to this research project. A description of the study context was given and why a particular city was selected as the study site as well as the procedures followed in the selection of the research participants. There are a number of ways to collect information from the participants, however a semi-structured interview was chosen, whereby the interview questions were guided by the themes developed from the best practice models in the different sectors studied in chapter 3. A qualitative data analysis software QDA miner was employed for the thematic template analysis of the data which is presented in chapter 5. Thereafter, the data was interpreted to develop a conceptual model discussed in chapter 6; and the conceptual method was validated in chapter 7.

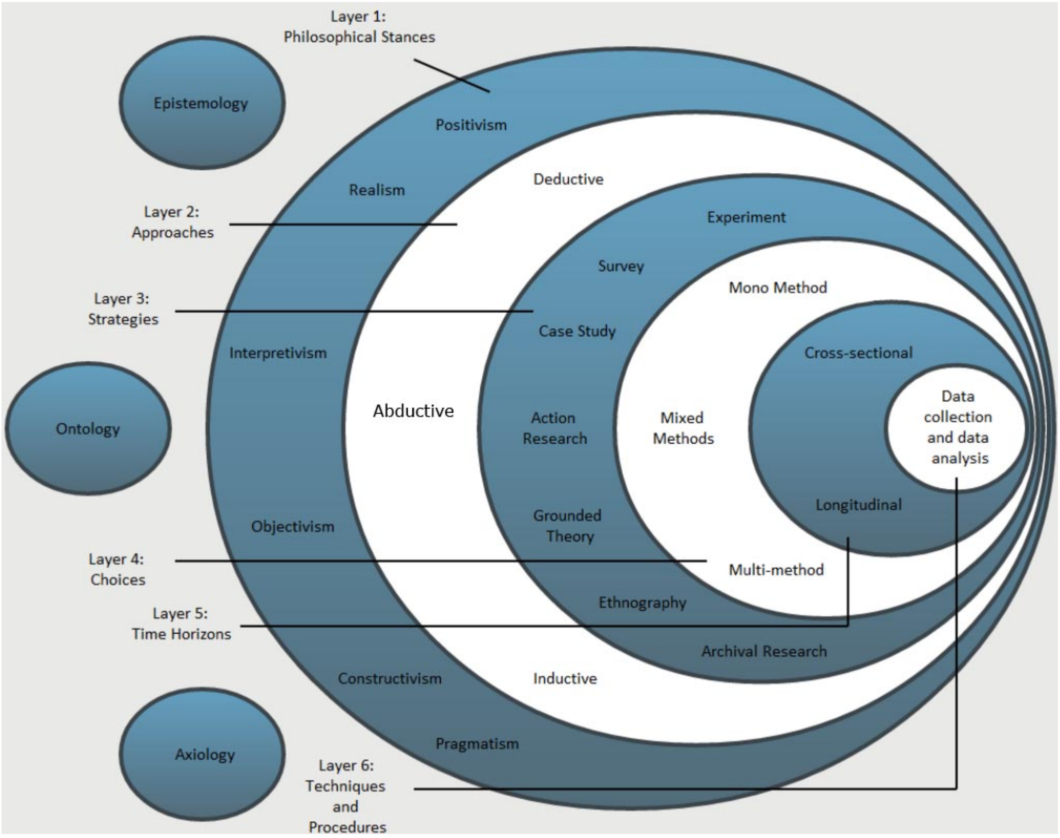


Figure 16: Research Onion (Saunders et al, 2009)

4.2 The Research Philosophy

Sustainability, which is the basis of this study, is a controversial concept that is subject to vehement oppositions, as much as it enjoys massive support as demonstrated in the north-south dichotomy discussed in chapter 2.2. It is such controversial that even the authors of one of the most influential publications on the subject, "*The Limits to growth" Report* *for the CLUB of ROME'S Project for the predicament of Mankind,* that attracted the world's attention towards sustainability differ on some fundamental issues (Meadows, Randers, Meadows, & Meadows, 2004, p. xvi). The "about-turn" process in the human industrial activities from the unsustainable path to the new path of sustainability (see chapter 2) is a typical example of a subject representing different informed and sophisticated human constructions that changes over time. Less informed and less sophisticated perception gives way to a more informed and more sophisticated one (Guba & Lincoln, 1989), as with the case of Gaia theory and sustainability concept.

The phenomenon covered by this study is considered worthy when viewed through the sustainability lens. However, if the same phenomenon should be viewed from the perspective of some oriental philosophies that do not believe in the workability of sustainability as a concept (Brandon & Lombardi, 2011), or to the political economist, it might be interpreted as yet another vicious example of disreputable practice or interclass atrocity. The inclination of the researcher to evaluate the subject using the sustainability parameters is a proof of a bias. Researchers may sometimes be unconscientious of the values guiding their actions; however, that does not absolve them from holding any value as it might be claimed. Therefore, the claim to be value neutral is a position that is arguably impractical for humans (Guba & Lincoln, 1989, pp. 127-128). Saunders et al. (2012, p. 139) suggests that it is preferable for the researcher to be honest and highlight the personal values that may have impact on the research process or the conclusion therein. As adherents to different value systems will eventually give different priorities to different themes, there will emerge multiple truths about any subject of discourse, i.e. *multiple values imply multiple truths* (Guba & Lincoln, 1989).

The idea of *multiple truths* coincides with the relativist ontology of the constructivists. According to this philosophical school, any supposition can only be true or otherwise relative to a particular human construction and the level of sophistication and information associated with such construction. The existence of multiple truths is acknowledged not only in the constructivism philosophical views, but also in critical realism or critical multiplism were multiple realities are accepted to be constructed based on the views of a particular field of study (Guba & Lincoln, 1989, p. 85). The co-existence of multiple constructions with the same level of sophistication and information about a topic is another possibility. While on the other hand, the more sophisticated and informed a construction, the harder it is to challenge (Guba & Lincoln, 1989), as in the case of sustainability.

This explains the situation of our main treatise- *the Nigerian practices of the end-of-life management of buildings*, which may be viewed as a more acceptable practice according to the waste hierarchy (section 2.5.2). The concept of the waste hierarchy is guided by the sustainability principles, which can be considered as rather a much more informed and sophisticated thesis relative to the alternative understandings such as the *Gaia Theory* that is now out of favour. Nevertheless, for the fanatical scientist, truth is an absolute reality that exist independently irrespective of any human conception (Guba and Lincoln, 1989, pp.84-85), a position that cannot be valid for our topic of inquiry as discussed above.

On the other hand, this study is an investigation of a phenomenon considered analogous to the study of the interactions of organisms in the natural ecosystem. Therefore, if the subject of inquiry is to guide the subscription to any of the philosophical schools of thoughts, it is the position of the natural scientist that should be assumed. This implies that the study should be undertaken from the *Archimedean point*, i.e. detached from the object of the study, as would be suggested by the conventional positivist, whose views we just discarded while establishing our ontological position. This is an abomination to the paradigmatic extremist who in the words of Bryman (2009) believes that *"no fraternising with the enemy is legitimate"*. According to the paradigm enthusiasts and other views such as that of Kuhn (1970) discussed in Bryman (2009) , multiple paradigms cannot be combined within a single study of this nature. Paradigm can be considered as a complete package of belief systems that provides a structure for intellectual undertaking (Guba & Lincoln, 1989; Saunders et al., 2012). Meanwhile, there is a conscientious attempt here to assume the position of *constructivism* on the ontological level, and switching to *objectivism* on the epistemological level, while these are known traditional paradigms that have been at "war" and considered incompatible by many (Bryman, 2009).

The pragmatism protagonists that disbelieve in adhering to any particular paradigm will suggest that such philosophical composition may be leading to their realm. In pragmatism, the research topic dictates the philosophy to be employed; and combination of more than one philosophical assumption in the same research undertaking is acceptable (Saunders et al., 2012, p. 678). The practical approach in pragmatism ideology qualifies it as a distinct school of thought from the paradigmatic stances that emphasize the dualism of positivism and interpretivism (Bryman, 2009). Nevertheless, based on the understanding of paradigm as an operational framework, pragmatism is an alternative position advancing the paradigms debate from the dualism to threesome (Bryman, 2006, pp. 97-98). It is therefore a pragmatist stance that is adopted in this study.

4.3 The Research Approach

Chapter 2 of this thesis discussed the status of the built environment in the sustainability agenda in general. The relevance of the built environment is evident in all of the social, economic, and ecological aspects of sustainability. One of the significant ecological impacts of the built environment is materials consumptions (Brandon & Lombardi, 2011, pp. 14-15), which is usually associated with wastes that form the focus of this study. As illustrated in Figure 17, a deductive style is already in operation when the broader idea of sustainability is beamed at the built environment, and thereafter the ecological aspect is isolated for attention. Among the many facets of the ecological impacts of the built environment, this study considered waste as a component of material consumption for evaluation within a particular geographical context of Nigeria. In other words, moving gradually from the theory of sustainability to the field where data will be collected, an approach described by (Saunders et al., 2012) as *deductive*.

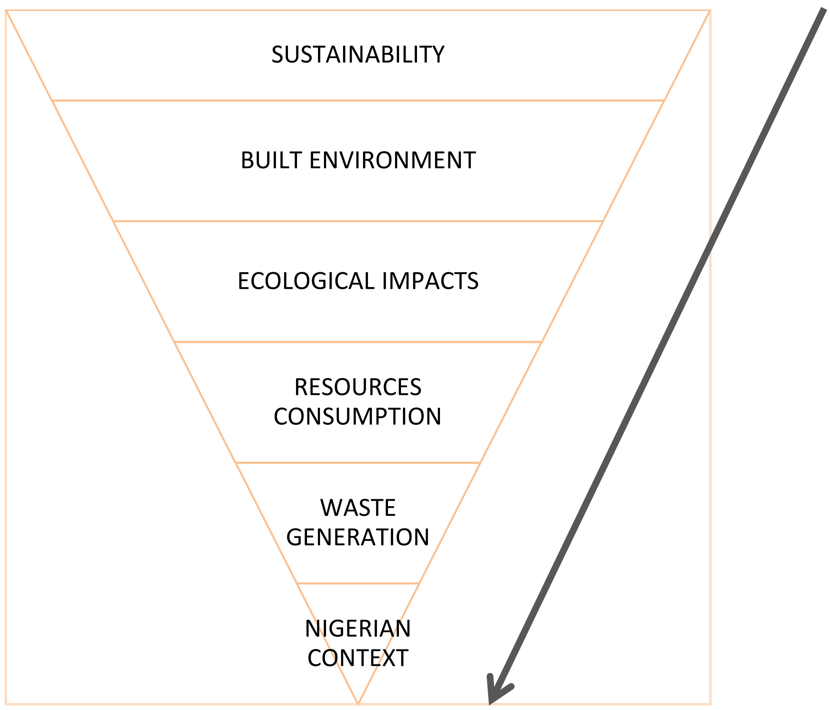


Figure 17: A DEDUCTIVE APPROACH TO THE RESEARCH TOPIC

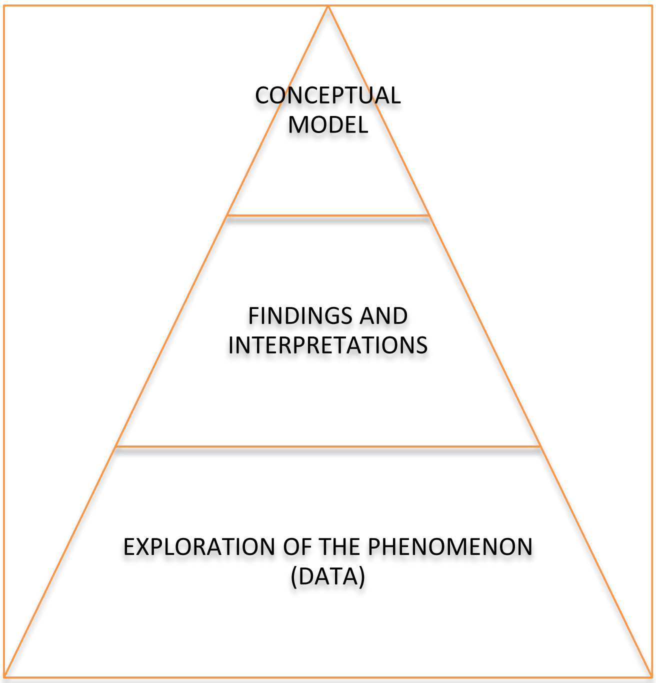


Figure 18: INDUCTIVE APPROACH

While deductive approach is implemented in the first section of this research as demonstrated above, the latter part of the project is planned to work in a reverse order. After the exploration of the practices of demolition waste management in the Nigerian context, the findings are to be utilised for a conceptual model in an inductive approach and thereafter the model was validated; thus moving from data to theory described as inductive approach (Saunders et al., 2012). Once more, multiple approaches are combined in the same study, by switching between deductive and inductive research logics, which is typical of *abductive* research approaches (Suddaby, 2006). However, abductive researches are characterised by probable theories as an attempt to offer the best possible explanation for an observation of an amazing fact (Van Maanen, SØRensen, & Mitchell, 2007). This coincides with the style of this study, whereby the concept of industrial ecology along other best practices models serve as the probable theory that may be used to explain the *"surprising observations"* in the Nigerian management practices of demolition wastes. This exhibits the back-and-forth feature, which is usually associated with abductive research approach. It is therefore an abductive approach that was used in this study.

4.4 The Resaerch Strategy

On the technical level, there are several techniques otherwise referred to as strategies (Saunders et al., 2012), that are used for practical research undertaking. This includes performing an experiment, conducting a survey, or the use of archives. Case study, ethnography, and action research are among the checklist of research strategies. Others are grounded theory, narrative inquiry, content analysis, and feminine research among others. This section is an overview of some of these strategies applicable in the built environment that are discussed for suitability in achieving the objectives of this study.

4.4.1 Experiment

Experiment is a test to prove that a change in one variable, called independent variable, affects the other variable called dependent variable. This is referred to as causality and can be between two or more variables. Where an experiment involves humans, the participants may be referred to as subjects (Patzer, 1996). The ability to control the main elements of research and to ascertain the causal relationships between elements are the two prerequisite features of an experiment that are interdependent on each other.

Where an expression of causality suggests that a change in one variable causes a change in the other variable is referred to as deterministic causation, i.e. perfect causation, which is uncommon in real life. However, where the expression of causality suggests that one element is likely to cause change in the other, is referred to as probable causation, and is more likely to be encountered in real life. This is because in real life, multiple variables are more probable to produce the result rather than only one. Additionally, it is not practical to establish causal relationship with absolute certainty; it is therefore better expressed as one factor likely increased the possibility of the other. Alternative explanations should also be sought to explain the causality between two or more variables before a conclusion is made (Patzer, 1996).

This method may not be suitable for the subject of this inquiry as experiments are only possible if the researcher can have control over one or more variables and the research questions should be seeking for causal relationship. While the research objectives of this study may include the factors that influence the prevalence of the phenomenon, it was impractical to control any of the variables in the study such as the national economy, culture, and tradition. Experiment is therefore not considered suitable for this study.

4.4.2 Survey

As an alternative to making conclusions about a population unsystematically based on individual anecdotal experiences, quantitative survey research provides a more systematic system of collecting and analysing data and making conclusions about the entire population (Nardi, 2006). When the population under study comprises of few numbers, the entire population can be surveyed and the data can be used to form an opinion. Nevertheless, where the population is very large, as that of an entire country, a survey of the entire population may not be feasible. A system of selecting a representative members of the population whose characteristics can be generalised to the entire population will be required to operationalise the survey procedure (Nardi, 2006). Therefore, survey research can be defined as a systematic method of establishing archetypal characteristics of a population based on a logical sampling technique.

Quantitative data collection and statistical analysis techniques are common features of survey research that may be used to answer research questions of the ‘what’, ‘who’, ‘where’, ‘how much’, and ‘how many’ types (Saunders et al., 2012). Survey researches may be suitable for testing hypothesis using dependent and independent variables while employing the reliability and validity protocols (Nardi, 2006, pp. 42-65). Questionnaires are typical tools for survey research, nevertheless, structured interviews and observations are the other techniques that may be used in a survey research (Nardi, 2006; Saunders et al., 2012).

While survey researches are conducive for pre-coded questions from the already developed concepts and hypothesis (Nardi, 2006), and may otherwise be considered suitable for this study, it was however considered inappropriate for achieving the research objectives of this study where processes and an undetermined population was involved. Survey was therefore not used in this study.

4.4.3 Content Analysis and Archival research

While in survey humans are the subjects of studies where their responses are coded and analysed as the primary data, in content analysis research it is the written, visual, audio, or any other communications produced by the people that is used as the data for analysis. These may include diaries, newspaper, biographies, and official documents (Nardi, 2006). An example of research where contents analysis was used is the evaluation of how researchers in social science use mixed methods in practice by Bryman (2006). He examined 232 different articles in social science where both quantitative and qualitative methods were combined in the same research project. In this example, the handwork of the people was used in the research instead of involving the people directly. Where historical documents are involved, it is sometimes referred to as archival research (Nardi, 2006, p. 16).

Content analysis and archival researches are only possible subject to availability and accessibility of the documents (Saunders et al., 2012, p. 179). This is part of the reasons the use of content analysis in this study was not contemplated. Notwithstanding, where any relevant documentation becomes available serendipitously, the researcher will not hesitate to use the opportunity. It is likely that some Government departments like the refuse management agencies may have records related to demolition wastes, which would be useful to this study. Nonetheless, such opportunities were not available at the time of collecting data for this study.

4.4.4 Ethnography and Participant Observation

According to Yin (1981), ethnography is simply a data collection method rather than research strategy, nevertheless ethnography is sometimes considered as both a research method and a writing style (Bryman, 2012, p. 462); Watson (2011) remarked that it is a style of writing and evaluation which may utilise a number of other methods. It is a technique involving the researcher in a lengthy period of insider observation in a social setting and the findings are presented in a unique genre of ethnographic text. The researcher usually immerses self to become a member of a group under study for a period that may last up to 7 to 10 years with the aim of understanding and documenting some characteristics of the group (Bryman, 2012, p. 464). Ethnography is an age long strategy that evolves from early 18th century to the beginning of the 20th century, to date (Saunders et al., 2012, p. 181). Nevertheless, the old strategy has transformed in format and applications, that authors recognise 3-4 different types of ethnography (Bryman, 2012; Saunders et al., 2012).

In the earliest realist ethnography, account of culture is presented from the position of an outsider with an attempt to provide an objective story of cultural patterns, a style that is most typical of ethnography. Interpretive ethnography otherwise called confessional tales are presented in first person implying the researchers rather insider interpretation while at the same time giving attention to alternative meanings that may be associated with participants. Another group is critical ethnographers who seek to influence wider action on the phenomenon under investigation (Saunders et al., 2012).

Four features are typical of ethnography, as enumerated by Atkinson and Hammersley (1994). Ethnographic studies are not likely to test hypothesis, nevertheless tend to discover social patterns, and the use of unstructured data is typical. Detailed study of minimum number of cases, sometimes only one, while providing interpretation and meanings to actions is common. Participant observation in the form of complete observer, observer as participant, participant as observer, or complete participant (Atkinson & Hammersley, 1994), has long been associated with ethnography, nevertheless other methods such as interviews are increasingly applied as ethnography transforms into less intensive formats (Bryman, 2012).

As researches with shorter period of contacts with the site of study is becoming more acceptable due to the changing nature of the subjects and career requirements of researchers (Bryman, 2012), ethnography may be considered ideal for this study. Nevertheless, the period of contacts available to the researcher is very limited to permit the use of ethnography in this study.

4.4.5 Case Study

While other strategies were considered unsuitable for this study for the different reasons enumerated above, case study is considered appropriate for achieving the objectives of this study as a descriptive and explanatory investigation of a phenomenon. Case study describes contemporaneous inquiries into real-life situation usually with unclear distinction between the context and the subject of study and the researcher has minimum control over happenings (Yin, 1981, 2009). In other terms, case study research can be defined as an intensive, holistic description and analysis of a phenomenon such as a program, an institution, a person, a process, or a social unit (Grünbaum, 2007).

There are features identified to characterise case study from other research strategies. A case study object is usually related to people and the interpretations of a phenomenon from the perspective of the social actors. The phenomenon of the study should usually be contemporary; and a holistic approach should be adopted to identify contextual factors around the unit of analysis. Case study researches are basically qualitative, descriptive, exploratory or explanatory used in generating or modification of a theory. The phenomena in case study researches are usually beyond the control of the researcher. Different data collection techniques may be applied for increased understanding to produce thick description (Grünbaum, 2007).

Data collection and analysis in case study researches are often guided by theoretical propositions, and utilises multiple variables and sources of evidence that may need to converge by the use of triangulation. The distinguishing feature of case studies from ethnography is the appropriateness of theoretical predisposition prior to data collection. Case study is commonly used to provide detailed account of current event with higher tendency to appropriately answer questions of the "*how*" and "*why*" types. Small group behaviour, organisational and management processes, neighbourhood change, international relations, and individual life cycles, are some of the real-life events that were reported to be investigated by the use of case study (Yin, 2009, p. 4). Single or multiple case studies have proven to be very useful in providing exploratory, descriptive, and explanatory investigations; and its suitability usually depends on the degree of control over events, relevance of contemporary issues, and the nature of the research questions. While the theoretical preposition of this study has been discussed in chapters 2 and 3, the research objectives suggest that this research will be descriptive and explanatory in nature.

Case study may not be favourable to universal or statistical generalisation; however, it can be generalizable to theories and should be reported free from bias as in other research strategies. Irrespective of the common tendency to associate case study with longitudinal investigations as in ethnography and participant observation, good case study investigations can be accomplished using other techniques of data collection. Moreover, case study can be used to complement other research strategies like experiments, specifically to address the *“why”* and *“how”* questions (Yin, 2009); which coincides with the objectives of this study.

Yin (2009, p. 27) suggested five components for designing a research that is to use the case study approach. These are the questions, preposition, unit of analysis, the logic linking the data to the prepositions, and the criteria for linking the findings. The study questions, the unit of analysis, and the preposition of this investigation have been enumerated in chapters one through three. The logics linking the data to the prepositions and the interpretation criteria are the tasks set to be accomplished in this chapter. While chapter 5 and 6 discusses the findings in relation to the objectives of the research.

There are four types of case study research design based on the number of cases to be analysed and the units of analysis. These are the single-case holistic designs, single-case embedded designs, multiple-case holistic designs, and multiple case embedded designs. Case study researches are designed as single-case for critical test of a theory, a unique circumstance, a typical case, or for revelation and longitudinal purposes. While multiple or comparative case designs may not be suitable in any of these situations, it is considered more robust than single-case designs, especially if replication produces similar results. Replication in multiple case studies can be lateral or theoretical, whereby in the former similar results are expected while in the latter contrasting results are predicted (Yin, 2009). Due to constraints in resources and time, this study is designed to be a single-case embedded multiple units of analysis case-study (Fig 19). However, to improve the quality of the research design, the findings will be tested using the different case study research validity test.

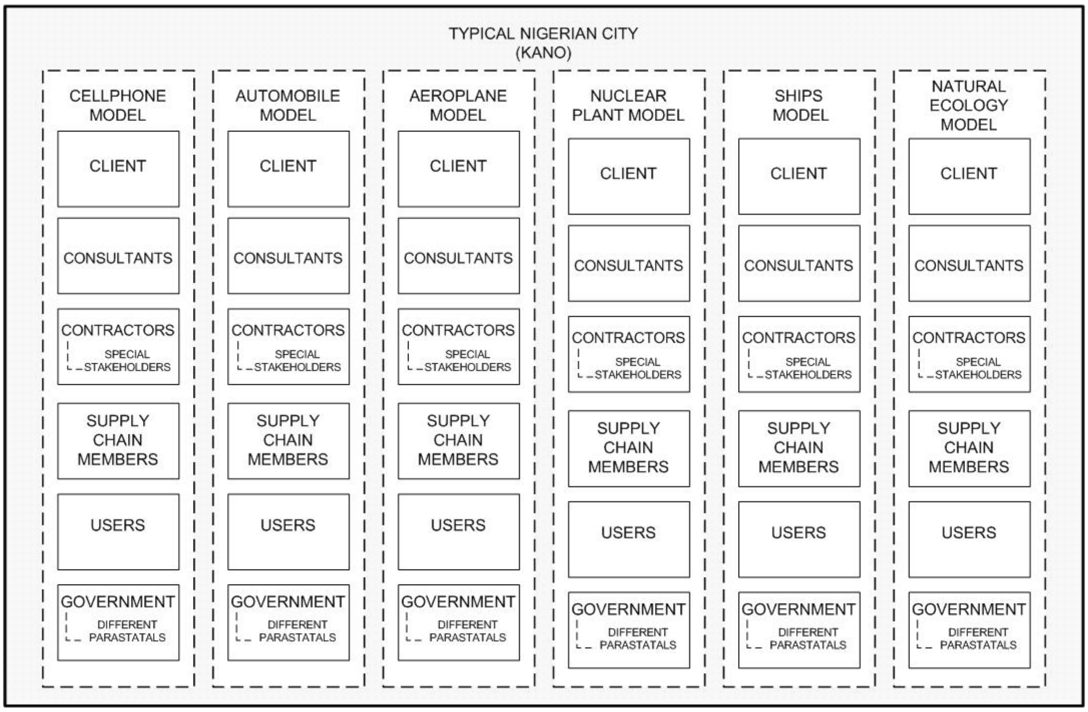


Figure 19: Single-case embedded multiple units of analysis case study adopted from (Yin, 2009)

Construct validity, internal validity, external validity, and reliability are the four tests that can be used to judge the quality of case study research (Yin, 2009). Construct validity can be achieved using multiple sources of evidences, establishing a link to evidences and report review by the participants. In this study, the validity of the findings from the data collected by semi-structured interview was validated through a focus group workshop. The four components of internal validity that are applicable in explanatory case study research are pattern matching, explanation building, addressing rival explanations, and using logic models which were utilised at the data analysis stage of this study. While statistical generalisation typical with survey research may not be applicable in case study research, analytical generalisation has been partly implemented in this study. The procedures followed to conduct this research were documented so that the process can be repeated and same conclusion arrived as recommended by Yin (2009).

4.4.6 Other Strategies

The list of research strategies as discussed above is not exhaustive, others not considered suitable for the research questions of this investigation include, action research, grounded theory, and narrative inquiry. Action research is usually an applied investigation aim at finding solutions to real life problems. It involves continuous evaluation and re-diagnoses, re- planning, and taking action until a solution appears to be in sight. Grounded theory refers to the research strategy where theory is developed from the data, rather than collation of data with a preconceived theoretical presupposition. Narrative inquiry on the other hand, is a research strategy based on a narration by an individual for the purpose of interpretation and reconstruction of order of events (Saunders et al., 2012).

4.5 The Research Method

Traditionally quantitative or qualitative analyses in research are related with one philosophical school or the other. Characteristically quantitative research analysis is assumed to represent the positivist ontology and objectivist epistemology, while qualitative research becomes synonymous to constructivist ontology and interpretive epistemology. This approach is so much entrenched that the two technical terms are used interchangeably with the philosophical terminologies as demonstrated in the writings of Kuhn (1970) (Bryman, 2009, pp. 13-14). Bryman appeared to be so flabbergasted by this observation as to remark: *"quite why philosophical issues became entwined with matters of research practice to this degree is unclear."* He alluded that it might be the effect of an effort by qualitative researchers to create merit for their relatively new approach, as it develops to provide alternative to the traditional scientific positivist approach. In anyway, it is logically sensible to provide an epistemological underpinning for any research undertaking for the findings to have credibility in the world of knowledge.

It is not surprising then when Saunders et al. (2012, p. 164) attempted to explain the combination of manifold research analytical procedures and data collection systems as the expected outcomes of some philosophical suppositions. The critical realists and pragmatism were cited by these authors as examples of philosophical assumptions that are more inclined to beget multiple research methods. While any of the inductive and deductive research logics can possibly work with multiple research method, it was described as more friendly to the combination of the two, or rather abductive approach (Saunders et al., 2012). The pragmatic philosophical stance and abductive approach of this research as discussed in the previous sections of this chapter twist it towards the multiple or mixed method strategy. Moreover, the philosophical positions assumed in this research are more favourable to the use of mixed methods.

A mixed methods research as described by Bryman (2008), refers to any one research undertaking that combines both qualitative and quantitative researches. Saunders et al. (2012) however, employed the term multiple methods and described it as the practice of answering research questions by utilising a plurality of data collection techniques and analytical procedures. Furthermore, they distinguished mixed method from multimethod, whereby mixed method was expatiated as the single, or multiple phase incorporation of data collection techniques and analytical procedures that transcend the traditional qualitative and quantitative researches dichotomy. Multimethod on the other hand, may incorporate diverse data collection techniques without necessarily crossing the traditional boundaries. A research can be labelled as *partially or fully integrated mixed method research* depending on the use of different methods throughout the stages of the research or at only one stage or the other (Saunders et al., 2012, pp. 164-166).

Nonetheless, philosophical supposition is not the only reason that can influence a research undertaking to adopt mixed methods. On the contrary, Greene, Caracelli, and Graham (1989) identified five justifications that might prompt the choice of mixed method for a research project. These are triangulation, complementarity, development, initiation, and expansion. *Triangulation* was clarified as intentional use of different methods with contrasting biases to examine the same phenomenon for possible convergence of outcomes, thus improving the legitimacy of the results. *Complementarity* refers to, elaboration, enhancement, illustration, and clarification of findings from one method by another. Situation where findings of one method serve as the determinant factor for employing the other method was referred to as *development*. *Initiation* on the other hand is used to describe the practice of using one method for better appreciation of the subject of inquiry to "kick-start" the research process while a shift to another method may become imperative at a later part of the research. Mixed method may be used as what was termed *expansion*, to broaden the scope of the research whereby different methods may be employed for different aspects of the research (Greene et al., 1989).

While the Greene et al. (1989) prominent framework for the possible explanations for using mixed methods in research was limited to five, in their essay on the application of mixed methods in the built-environment research, Dilanthi, David, Marjan, and Rita (2002) recognised only three of such reasons that may warrant the use of mixed-methods. Nonetheless, the three reasons cited by these authors coincided with the triangulation, development, and initiation as enumerated in the (Greene et al., 1989) concept.

On the other hand, Saunders et al. (2012, p. 169) acknowledged all the five reasons enumerated by (Greene et al., 1989) with slight difference in terminologies; and moreover, five additional justifications for mixing methods in research were enumerated by them. According to these authors, the utilisation of one method for the "*interpretation*" of another can be a reason for combining methods in the same research. They also argued that, it is important in some studies to present "*diversity of views*" provided by the use of more than one method. Moreover, they believe that the findings from a research conducted using one method may not be satisfactory, and therefore the use of another method is justified to *"solve problem"*. Furthermore, it was reasoned by these authors that, researchers might sometimes realise that it will be more fruitful to *"focus"* a varied method for dissimilar aspects of the research. Moreover, in another situation researcher may simply wish to have greater *"confidence"* in the results generated in a research by mixing methods to arrive at a conclusion. Hence, *interpretation, diversity of views, problem solving, focus, and confidence* were the five additional justifications for mixing methods in research developed by Saunders et al. (2012).

The resolve to adopt a pragmatist stance provides the opportunity to employ a plethora of methods, which as discussed above, there exist a menu of ten justifications for using multiple methods in a single research. Nevertheless, adopting pragmatist philosophical stance does not suggests employing multiple methods automatically in all circumstances; rather it is a situational decision whereby the research questions or objectives determine the methods to be invoked to provide the best possible answers.

It is important to note that, the research objectives 2 and 3 are answered in a descriptive format in the literature review in chapters 2 and 3 which is a characteristic of qualitative researches as highlighted by (Bryman, 2012, p. 401). He described qualitative researches as being characterised by "thick descriptions" with detail information on the context, which is more favourable to idiographic approaches rather than nomothetic. In this approach, processes and sequential development of events with time are stressed, while the participants are usually little. The interconnection between different aspects and the resultant phenomenon is studied over long period. Participant observation as in ethnographic studies is commonly associated with qualitative researches; however, same results can sometimes be obtained through semi-structured or unstructured interviews, and documents analysis (Bryman, 2012, pp. 402-403).

Additionally, qualitative researchers prefer hermeneutic and dialectic approaches (Guba & Lincoln, 1989), to understand the context of study in the perspective of the participants while adopting the posture of "learner-insider" (Blaikie, 2007, p. 11), rather than imposing a preconceived stature on the enquiry. This is in direct conflict with the approach adopted in this research as explained in the previous section, where the reverse is the case. Nevertheless, as purism is not the accepted *"modus operandi"* of this inquiry, the most appropriate method will be deployed as a respond to the nature of the objectives of the study sought to be achieved, which is in line with the argument of Yin (1994). Moreover, a qualitative approach to quantitative research and vice versa, can be an acceptable practice in research (Bryman, 2012, pp. 622-624). Consequently, the other research objectives were tackled using the most appropriate method, which was considered qualitative, and is in agreement with the epistemological stance established earlier.

Nevertheless, qualitative researches are criticised as being subjective, difficult to replicate or generalised, and lack of transparency (Bryman, 2012, pp. 405-406). These same attributes make the credibility of quantitative researches to be assessable whereas in qualitative researches there is no consensual criteria for assessment (Hammersley, 2008). Contrastingly, qualitative research purists Guba and Lincoln (1989), argued that such set of criteria for assessing the quality of an inquiry can only be valid for inquiries grounded in the positivist ontology and epistemology. They rather suggested an alternative set of criteria for assessing the worth of qualitative research that is grounded in the constructivist philosophy as discussed below (Guba & Lincoln, 1989, pp. 233-251).

Credibility is the equivalent of the internal validity in quantitative research, which is used to prove a causal relationship between variables. Prolonged engagement, persistent observation, peer debriefing, negative case analysis, progressive subjectivity, and member checks are suggested as the techniques that may be used to improve the worthiness of a qualitative investigation. The effect of misinformation and distortion can be minimised through long period contact with the study site and persistent observation (Guba & Lincoln, 1989, p. 237). Nevertheless, the same result can be obtained from the detailed account of participants that have been a part of the study site for long period as in this study by the use of an in-depth semi-structured interview.

Peer debriefing is an interaction and critique by a peer who is neutral as another check and balance method that can be employed to improve the worthiness of a qualitative inquiry. Alternative hypothesis testing and rejection referred to as negative case analysis is another way to reinforce the validity of a research that is qualitative in nature. The process of theory development can be monitored by a third party to guard against bias to the researcher's predisposition in what is sometimes termed progressive subjectivity. Member checks is another approach of establishing qualitative research credibility, whereby the participants crosscheck the interpretation of the researcher to confirm that it is truly representative of their views (Guba & Lincoln, 1989, pp. 237-241).

Generalisation is another concept not in tune with qualitative researches, as it suggests an existence of an absolute truth that is applicable to all situations. Moreover, it advocates that whatever concept is developed by the researcher can be assumed to function on all the subjects by the virtue of data obtained from a sample selected at random. Qualitative researchers alternatively view transferability of a research finding to be the preoccupation of the beneficiary who may consider it suitable for application in a different context. What qualitative researchers do is to provide a detailed study that is specific to time, place, context, and culture (Guba & Lincoln, 1989, pp. 241-242). While the measure of the stability of a concept throughout the study is considered a proof of reliability, in qualitative approaches paradigm shifts are expected part of a study and is considered reliable when such changes are documented, transparent, and confirmable.

Confirmability is a process of ensuring that the findings of a research are neutral and not influenced by the researchers' values, motives, biases, or political inclination. This can be achieved by making the findings and processes used to arrive at the findings transparent and available for inspection by a third party, in what was described as confirmability audit (Guba & Lincoln, 1989, pp. 242-243). They further argued qualitative methods that incorporate hermeneutic dialectic approaches whereby information obtained is immediately analysed and presented to the respondents for review is a self-correcting procedure that increase the worthiness of an inquiry. On the other hand, they contended that credibility of methods should not be emphasized to the detriment of the outcome of the research and fairness to the view of the participants and different type of authenticity mechanisms (Guba & Lincoln, 1989, pp. 245-250).

On the other hand, relativists and postmodernists de-emphasize these criteria as epistemic, and rather stressed the importance of political, ethical, and practical considerations. Nevertheless, there is no criteria whatsoever that can be used to assess the quality of an inquiry with absolute certainty, rather knowledge claim can only be judged on its most likely probability to be truth (Hammersley, 2008).

REGULATORY CRITERIA	**QUANTITATIVE METHODOLOGY**	**QUALITATIVE METHODOLOGY**
Veracity	Internal Validity	**Credibility:** *Prolonged engagement* *Persistent observation* *Peer debriefing* *Negative case analysis* *Progressive subjectivity* *Member checks*
Applicability	External validity/ generalisation	**Transferability**
Consistency	Reliability	**Dependability**
Neutrality	Objectivity	**Confirmability**
Method	-	**Hermeneutic/ Inter subjectivity**
Trustworthiness	-	**Authenticity** *Fairness* *Ontological* *Educative* *Catalytic* *Tactical*

Table 3: Validation Criteria in Quantitative and Qualitative Methodology after (Guba & Lincoln, 1989).

In the foregoing discussion, it has been demonstrated that the pragmatism disposition of the researcher paved the way for the use of any method that is most suitable to achieve the research objectives. A reflection on the study objectives as discussed in chapter 1 suggested that qualitative approach would be more suitable. Nevertheless, qualitative research is criticised for being subjective, non-transparent, not generalizable, and cannot be replicated. Qualitative researchers on the other hand provide defences for the quality of their approach that are parallel to the concepts used in the traditional methods as well as those that are unique to qualitative research (see Table 3). There is also another school of thought that disagrees with any epistemic criteria for judging the validity of research finding in favour of ethics, applicability, and politics. It was further observed that no criteria could be used to certify any research finding with absolute certainty, except its likelihood to be correct. This provides the theoretical background that justifies the suitability or unsuitability of the practical technique(s) employed in the field. One of the practical constraints in a study of this nature is time, as discussed in the following section.

4.6 Time Horizon

Engagement with the subject of study for a prolonged period of time, described as a longitudinal study is associated with qualitative researches as in ethnography and case study with participant observation as the technique for data collection (Yin, 2009). Nonetheless, good outcome can be obtained by other techniques of data collection such as interviews that are cross-sectional and do not require a prolonged engagement with the subjects (Yin, 2009. The time constraint in this study permits only the use of cross-sectional data collection methods as described in section 4.8.

4.7 The Study Site and Selection of the Research Participants.

As discussed in section 4.5.5, reliability as a measure of the quality of an investigation is determined by the documentation of the procedures followed in the research, to enable repetitiveness of the research with symmetrical conclusions. While the data collection technique to be used in this research will be discussed in section 4.8, the procedure for selecting the research site and participants is discussed in this section.

4.7.1 Selection of the study site

Despite many subdivisions among cultures and regions, Nigerian society is mainly divided between the north and the south dichotomy, and is reflected in virtually all aspects of political, cultural, and economic life. Discussions of Nigerian cities is sometimes approached according to this line of cultural dichotomy (Phillips, 2003). Nevertheless, the township ordinance of 1917 was motivated by the complexities and heterogeneous nature of the townships that makes administration too challenging to the native administration to handle. Thus, the townships were classified into first, second, and third class townships (Olukoju, 2004). First class townships were administered by a council, while an administrator assisted by an advisory board was nominated for the second-class townships. Typical Nigerian townships that the township ordinance categorised as second-class were eighteen and despite emergence of more post-colonial townships (Olukoju, 2004), these remain major settlements and population centres to present date. Whilst the second-class townships were eighteen, Lagos was the only first class township administered by a council in line with its unique nature.

Figure 20: map of Nigeria showing some major townships (Adopted from Encarta Encyclopaedia, 2014)

Lagos may probably be one of the ten largest cities in the world by 2025 (Phillips, 2003, p. 54), largely made up of four islands interconnected with bridges that are barely adequate for the large population it accommodates. Characterised by pollution, crime, and overcrowd. Lagos was once a state and federal capital city with limited capacity for expansion (Chattopadhyay, Slack, Canadian Electronic, & Forum of, 2009; Phillips, 2003). This unique nature of Lagos was cited as the reason for relocating the federal capital city to Abuja based on the recommendation of a panel and subsequent military decrees and implementation. Abuja was purposely selected for its geographical location, climate, and neutrality and was designed and built as a modern administrative city (Chattopadhyay et al., 2009; Phillips, 2003). This description of Lagos and Abuja makes the duo not representative of a typical Nigerian city, therefore excluded from consideration as the site for this study.

Kano on the other hand is the most populous among the second-class townships recognised by the townships ordinances act of 1917 with heterogeneous composition (Olukoju, 2004), and currently remains a vibrant commercial and cultural centre, and second to Lagos in terms of population. Moreover, as described by Urquhart (1977), in the colonial period, four different types of settlements emerged in the urban centres of northern Nigeria with official recognition. The ancient walled city usually left intact, the European official settlements popularly known as GRA (an acronym for Government Reserved Area), the *"Tudun Wada"* as settlement for non-indigenous northerners, and the "*Sabon Gari"* as settlement for settlers from the southern Nigeria (Urquhart, 1977). This structure still exists in Kano and makes the city a confederation of all Nigerian nationalities; subsequently, this becomes a tradition as this structure can be observed in recently developed settlements and reports of events in the public news, like: *"Witnesses say … in the mainly Christian area of Sabon Gari"* (BBC, 2014). Moreover, the subject of this investigation is a serendipitous discovery in Kano. Thus, the three reasons for selecting Kano to be the study site are its population, heterogeneity, and discovery of the phenomenon in Kano.

4.7.2 Selection of participants

It was suggested that no matter how good an analysis might be; it cannot compensate for improperly collected data. The entire population forms the data for the subject of a research, however, as the whole population is not convenient for data collection in many circumstances, the use of statistical tools such as sampling and data reduction technique such as factor analysis and ordination becomes imperative (Tongco, 2007). One other technique is the use of purposive or judgement sampling which involves conscious selection of a participant due to particular attributes such as knowledge, experience, or being an actor in the phenomenon of investigation. Purposive sampling becomes employed where the researcher established the information required and set to find out, in a non-random manner, the right and willing participants to provide the needed information. Selection of the participants may be directly by the researcher, indirectly through key participants, or in a snowball fashion where identified participant(s) suggest other subsequent participants (Tongco, 2007).

While some researchers suggest that a minimum of five participants are needed for a data to be reliable, some other researchers opined that what matters is not the number of participants, but obtaining the right information and minimising bias. Random and probability sampling are recommended for minimising biases and extension of results to the entire population (Tongco, 2007).

Though purposive sampling may be used in both quantitative and qualitative studies, the question on the number of participants considered enough in qualitative studies has been recurring. There are divergent opinions among qualitative researchers on the issue of sample size ranging from as few as one; nevertheless, many suggest different ways to determine when the data is enough rather than numeric as in quantitative studies (Baker & Edwards, 2012). Saturation and variability are the most commonly cited determinants for making decision on the number of participants considered enough (Guest, Bunce, & Johnson, 2006). In a study that applies this principle in practice, it was realised that saturation can be achieved starting from 6 to 12 qualitative interviews (Guest et al., 2006).

In this study the attribute of the participants eligible for participation in the research was involvement as an actor in a minimum of one construction project involving building demolition. It was however realised that, while some of the experienced participants laden with information (like the contractors) were involved directly on the projects, others (like the supply chain members) were involved indirectly; or what Leung and Olomolaiye (2010) described as internal and external stakeholders.

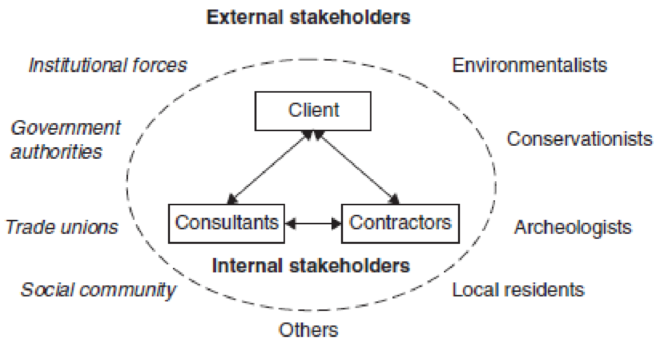


Figure 21: KEY CONSTRUCTION STAKEHOLDERS, ADOPTED FROM (Leung & Olomolaiye, 2010)

Therefore, for the purpose of assigning a quota of a number of research participants per category of stakeholders, context-specific groupings were developed for the purpose of this study (Table 5), based on two previous prepositions on construction stakeholder groupings.

While discussing the construction stakeholder management in Finland, Oyegoke (2010) categorised all stakeholders that are direct players in construction activities into five sub-groups. These groups include clients, users, supply chain members, financiers, and the public. The client is described as the most active stakeholder who sources for funds for the project as well as interacts with all other stakeholders. Users are the occupants of the completed structure as well as the primary source of income to repay back for the project. The stakeholders under the supply chain category are the various consultants, contractors, sub-contractors, and suppliers. The financial supporters are usually the bankers and equity investors. The public interest was suggested to be represented by different interest groups (Oyegoke, 2010).

In contrast, Leung and Olomolaiye (2010) in their essay on *risk and construction stakeholder management* equally grouped construction stakeholders into five, with slight difference with the (Oyegoke, 2010) scheme. According to these authors, the three construction internal stakeholder groups are client, consultants, and contractors, private and public external parties. The client group was categorised into public and private clients, while consultants' category may be internal or external and comprises of four to five different specialities. The third category of contractors and suppliers is made up of main contractors, sub-contractors, labourers, and suppliers (Leung & Olomolaiye, 2010). Table 4 below compares the two approaches (Oyegoke and Leung & Olomolaiye) to construction stakeholders' categorisation.

	Leung & Olomolaiye Approach	**Oyegoke Approach**
1	Clients	Clients
2	Consultants	Users
3	Contractors	Supply chain members
4	External private parties	Financial suppliers
5	External public parties	Community/public

Table 4: Comparative construction stakeholder groupings Leung & Olomolaiye Versus Oyegoke approaches.

Nevertheless, stakeholder groupings in building demolition may not be different from that of construction. Demolition from the Latin origin of the word simply means reversed construction process (Oxford Dictionaries, 2014). This implies that the construction stakeholders may be adopted for demolition exercises with some slight exigency modifications. Construction on the other hand, is described as a complex system characterised by autonomous agents, undefined values, non-linear social system with unclear social values, irreconcilable traditions, and competing interests (Bertelsen, 2003). To provide an appropriate answer to the question of who are the parties involve, will lead to the deeper look at the checklist and groupings of the stakeholders. Though stakeholders do not form the main subject of this study a complete and unbiased overview of the main subject of inquiry will require a stakeholder framework. The other fundamental aspect of this study is that it is context-specific. It is in view of this that the construction stakeholder groupings discussed above will be examined in the light of the demolition processes and the context of the study.

The first category of stakeholders as discussed in the previous section is the client, described as the main actor who interacts with every other party while sourcing for funding to sustain the project. It is not uncommon to assume the client to be a single unit comprising of an individual or individuals as observed by (Bertelsen & Emmitt, 2005). Nonetheless, these authors expounded that the client is yet another system as, or even more complex than the construction itself. Therefore, for the purpose of this discourse, a client will be considered as any individual, group of individuals, corporate, private or public institution that commission the demolition of a building and whose primary interest is to get rid of the structure as an unwanted article, otherwise referred to as demolition waste.

On the other extreme end are the users, whose primary benefit as stakeholders is in acquiring the “product” generated from the demolition exercise. In between these two ends of the continuum are the different parties who make gains from the process of actualising the transfer of the articles of the discarded building from client to user. These types of stakeholders are grouped into three: consultants, contractors, and supply chain members.

Consultants refer to the parties that primarily provide specialist intellectual services that guide the management and implementation of the desire of the client, which is demolition in this context. The contractors refer to the main or sub-contractors, skilled, semi-skilled, or unskilled providers of labour for the implementation of the blueprint for the demolition of a building structure. Supply chain members are the wholesalers, resellers, remanufacturers and upgraders whose interest is in the reverse logistics for the reacquisition and marketing of the articles produced from the building demolition exercise.

There is a unique group in the contractors’ cadre that attracted the attention of the researcher, the “scavengers” otherwise referred to as “purifiers”. This group of people create a specialised profession whereby they earn a living by salvaging and reselling materials from building demolition. How do they receive information about an on-going demolition is not clear? However, as a direct analogy to the scavengers in the natural wildlife, these groups appear virtually from nowhere wherever there is a demolition. It is a common sight to see them salvaging reinforcement from a demolished concrete structure. They constitute a significant group that should not be omitted in any study for the demolition processes in Nigeria.

As the primary focus of this study is handling of the materials in the process of building demolition, external stakeholders that are not directly involved in the process are deliberately downplayed except the Government whose role is considered to be vital in the process.

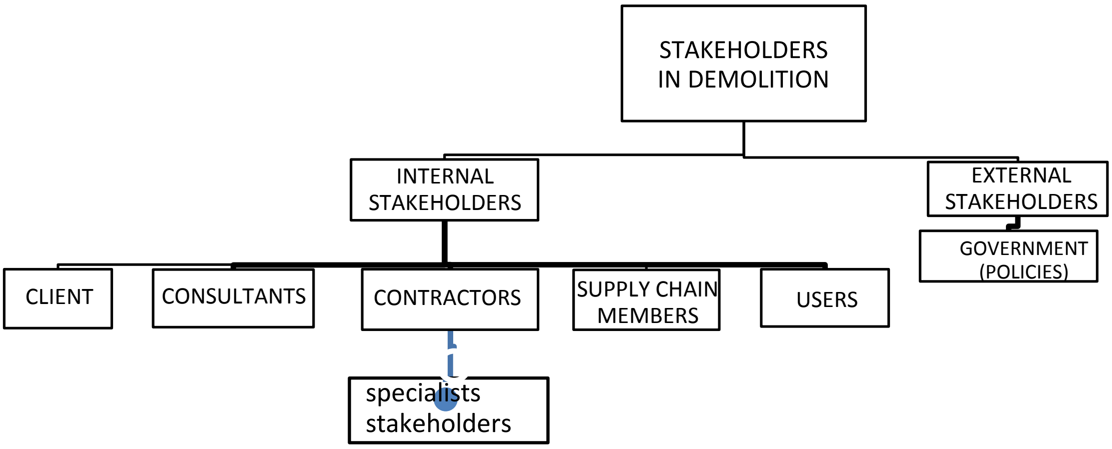


Figure 22: DEMOLITION STAKEHOLDERS

The selection of the research participants in snowball fashion involves identifying the first set of willing participants from these stakeholders. Thereafter, he/she will suggest other candidates to be interviewed until saturation is attained (Saunders et al., 2012). The proposed distribution of the research participants according to the stakeholder groups is indicated in table 5 below.

S/N	STAKEHOLDER GROUP	NUMBER OF PARTICIPANTS
1	Clients	3
2	Consultants	3
3	Contractors	3
4	Supply Chain Members	3
5	Users	3
6	Specialist stakeholders	3
7	Government Agencies	3
	TOTAL PARTICIPANTS	**21**

Table 5: Proposed Distribution of participants according to stakeholder groups

4.8 Data collection- the interviews

There are different methods for collecting data from the study site, including participant observation, structured observation, in-depth interview, group interview, and questionnaires. In this study however a semi-structured interview was used for data collection. This is in agreement to the descriptive objectives of the study as enumerated in section 1.6. The themes of the interview were the lessons learnt from the other sectors as described in chapter 3 (see appendices 5 and 6: The Interview Guides). The outlines of the interview along with the consent forms were communicated to the participants ahead of the interview. Participants were given the right of first choice for the venue of the interview. All efforts were made to get the confidence of the interviewees, and were briefed about the research and their right to withdraw. While guiding the interview to avoid digression, the researcher maintained neutrality and avoided giving hint to the interviewees. Technical terminologies that may not be familiar to the participants were minimised and explained where it becomes necessary. Peer debriefing was used in the development of the themes and questions asked.

4.9 The Data Analysis Procedure

Thematic analysis is one of the many methods for analysing qualitative data in form of interviews; nonetheless, there is a dearth in practical guides for using thematic analysis (Aronson, 1995). Thematic analysis refers to the discernable topics or behaviour patterns; while themes are the units of such topics or behaviours extracted from conversations, vocabulary, activities, sayings or proverbs (Aronson, 1995). King (2012) however, opined that themes should only be developed from repetitive topics in multiple cases or within a single case.

The procedure for conducting thematic analysis starts with the data collection, transcription and cataloguing of patterns and themes. Thereafter follows, the grouping of the data according to the established classification. Then related data patterns are regrouped into sub-themes. The analyst should then make efforts to rearrange the data to establish some rationality. This should be followed by arguments from literature to support the selection of the themes, and development of convincing explanation (Aronson, 1995).

This procedure is however most appropriate for ethnographic studies that the collection of data precedes the formation of themes. In this study, which is different from ethnographic studies, this procedure may only be partially applicable with caution using a combination of predetermined themes and new ones emerging from the data.

Another variation of the thematic analysis procedure is the template analysis that was described by its proponent as being flexible for use in different research scenarios, more especially with presumptive themes otherwise referred to priori themes (Brooks & King, 2014; King, 2012). The main feature of template analysis is a flexible coding template that may be developed without the need to comply to any rigid format or differentiating between descriptive and interpretive data. Template analysis was demonstrated to be applicable in a variety of methods including quantitative and qualitative (King, 2012).

The marking of texts for categorisation according to the themes is referred to as coding. In template analysis the codes are hierarchically organised with related codes grouped together under a more general higher code. While there may be multiple levels of codes under one major code, for the purpose of clarity the number of the hierarchies should be minimised. Lateral links between themes or sub-themes otherwise described as parallel coding (King, 1998), may be established by the use of other themes that may be relevant to multiple other themes. The hierarchical arrangement of themes in template analysis may be illustrated using a list or mind-map (King, 2012).

The agreement of the template analysis with the use of priori themes and its flexibility compared with other methods such as grounded theory and interpretative phenomenological analysis make it considered more suitable for use in the data analysis for this study. Nevertheless, it should be noted that the emphasis of the template analysis on repetitive themes suppressed the need for exploring all variations in the responses of the interviewees, which was incorporated in the analysis of data in this study.

Priori themes means that template analysis may be particularly well suited to studies with particular applied or theoretical concerns which need to be incorporated into the analysis. A priori themes becomes handy where the importance of a particular issue in relation to a topic is an established knowledge (Brooks & King, 2014). In this study the interview questions were developed from literature review, which qualifies it for the use of the template analysis.

The use of computer software is becoming more acceptable in aiding an analyst in coding data, search and retrieve information, and establish possible relationships (King, 2012). Some of the computer applications used by researchers for qualitative data analysis include NUD*IST, NVivo, Atlas TI, and QDS Miner. QDS Miner was used in the analysis of the data in this study. An initial 2 levels hierarchy was used in the analysis in this study for clarity purpose and the dictates of the nature of the data, however occasionally expanded to 4 levels at the final phase of the analysis.

4.10 Validation

Validity in qualitative research was introduced in section 4.5. There are divergent views as well as several technical jargons among authors about validity in qualitative research (Creswell & Miller, 2000).There are equally different attempts to classify validity in qualitative research as types, frames or positions. It becomes even more confusing when the “traditional validity” is compared with “ironic validity”. Nevertheless, the drive for emphasis on validity is largely towards instituting credibility for qualitative researches. This led some authors to become prescriptive about the guidelines for creating validity in qualitative research (Guba & Lincoln, 1989). One or a combination of triangulation, member checking, external audit, peer reviews, thick description are commonly used by researchers without necessarily any hint on why one approach may be adopted over the other. Creswell and Miller (2000) however, proposed that the choice of validity approach should be dictated by the paradigmatic propositions, as well as the viewpoint of the researcher.

Commonly, in qualitative research it is the views and perceptions of the people involved that validate the other in a research rather than the use of logical tools and extrapolations, such as external validity and content validity. Research findings, when considered asconstructs and interpretations of the researcher, may therefore be validated by obtaining the viewpoint of another party directly involved or not involved with the research. This stems from the philosophical assumption in qualitative research that reality is socially constructed.

Postpositivists, constructivists, and critical influence researcher are the three possible positions for a researcher on the continuum of philosophical paradigms according to Guba and Lincoln (1994). Any of these three positions may influence the approach to validity in qualitative research and was a dominant thought at one period or the other in history. The postpositivists approach to validity is to find qualitative equivalents of the validity instruments used in quantitative research (see section 4.5). The constructivists on the other hand were more flexible and used approaches and terminologies for validation that are unique to qualitative researches without making any reference to the quantitative technics. Contrarily, the critical researchers were indeed critical about the concept of validity in qualitative research and argue that the researcher’s value cannot be dissociated from a research and advocated for self-disclosure and reflexivity, based on the believe that *"What we see depends on our angle of repose"* (Richardson, 1994).

Built upon the 2-dimensional framework of researcher's viewpoint and philosophical position the nine different forms of validity procedures commonly used by qualitative researchers are: *Triangulation, disconfirming evidence, researcher reflexivity, member checking, prolonged engagement in the field, collaboration, and the audit trail. Others are thick rich description, and peer debriefing* (Creswell & Miller, 2000).

Triangulation is a procedure that seeks the convergence of different sources of data (e.g. participants), methods (e.g. interview, document, focus group), of different researchers, or sources to compliment the findings of the other.

Disconfirming evidence is another validation procedure whereby the researcher re-examines the data for contradictory themes in comparison to the initial themes. It is regarded as less robust in relation to the other procedures as it is practically difficult for the researcher to disengage from the sentiments of the original viewpoint.

Researcher reflexivity refers is a self-disclosure procedure where the researcher acknowledges the values, beliefs and other sentiments that might have influenced the research. This may be incorporated into the overall story or as a separate section of the piece, e.g. as an epilogue.

Member checking is considered by some authors as the most important procedure for establishing credibility in qualitative research. The procedure requires the researcher engaging the research participants to confirm the data and interpretations as truly representing their account. This procedure opens the interpretation and viewpoints beyond the researcher by incorporating the perspectives of the research participants.

Focus group discussions among the research participants to discuss the accuracy of the interpretation of the data are usually associated with this procedure.

Commonly practiced in ethnographic research is a *prolonged engagement in the field*. This provides the researcher with the opportunity to validate findings and themes generated by one method with another method. For instance, findings from interview may be verified by observations. Moreover, it increases trust between the researcher and the participants.

Alternatively, *collaboration* with the research participants as co-researchers, and co-writers formally or semi-formally is another procedure for validating the credibility of a research. The research participants may be involved in all of data collection, analysis and interpretation, and sometimes the authorship of the results.

The audit trail involves persons external to the research that the researcher presents the procedures used conducting the research and the analysis and interpretation for their independent view. The external party (auditor) reviews the research documentation in the light of the relevance of the findings to the data, logical inferences, categorisations, methods, and degree of bias.

Thick and rich description can be used a s a procedure to increase the credibility of a qualitative inquiry whereby the context, research participants, and the themes are defined in details to enable the reader have the feelings of experiencing the activities of conducting the research. This is achieved through an account of how the research was conducted including every miniature details, which makes the readers assume the same viewpoint as the researcher, thus increasing the credibility.

Peer Debriefing means peer review of the entire research process and the data by a party external to the research but familiar with the research context or methods. Such reviews usually last for the entire period of conducting the research.

Creswell and Miller (2000) recommended employing multiple procedures in research while acknowledging the challenges of using some procedures like triangulation of methods, prolonged engagement in the field, and thick descriptions. Furthermore, the significance of member checking, records keeping, and collaboration with research participants was emphasized. The three philosophical positions were all considered important and its applicability depends on the nature of the research project and the paradigm stance of the researcher.

4.11 Conclusion and Link

In this study, while philosophically the researcher adopted the constructivist position ontologically and interpretivist epistemologically, an abductive logic was used in approach. On the other hand, the case study strategy was employed to design the research, which turned out to become a qualitative inquiry in response to the research objectives despite of the pragmatist stance of the researcher.

Semi-structured interviews were used as data collection techniques and the template analysis was employed in the analysis of the data. The data was interpreted to generate a conceptual model; and two workshops were organised for a focus group discussion to validate the findings and interpretations of the researcher. As will be discussed in chapter 7, the workshop participants comprised of the participants and other external members to the research. The workshops served as a focus group discussion to triangulate the interview findings and the conceptual model as a representation of the real life story. A presentation was made by the researcher followed by comments and discussions by the workshop participants. The discussion was moderated by a third party in manner that was slightly different from the procedure for conducting focus group as recommended by Rabiee (2004).

Moreover, as some of the research participants were part of the workshop, it provided an opportunity for member checking. On the other hand, the role of the academic advisor to the researcher was described as a kind of peer debriefing. There was a combination of the elements of focus group, member checking, and peer debriefing in the validation of the findings and interpretation of this study. The findings from the data and discussions are presented in the following chapter.

Chapter 5 : The Practices of the End-of-life Management of Buildings in Nigeria.

5.1 Introduction

The findings of the research are presented in this chapter based on the priori themes generated from the review of the best practice models in different sectors as discussed in chapter 3 and new emerging codes generated from the data. The theoretical presupposition makes the case study approach adopted in this research distinguishable from ethnography (Yin, 2009). The preconceived themes guided the semi-structured interviews, while incorporating new emerging themes in the analysis. Selection of the participants based on the case study design and sampling technique discussed in section 4.7.2 will be described in section 5.2, followed by the description of how the interview was conducted in section 5.3. The procedure applied for the thematic template data analysis used in this study will be discussed in section 5.4. The findings and interpretations of the data are presented in section 5.5 through 5.11; which covers *the sustainability in the practices of building demolition in Nigeria*, *the description of materials handling when buildings are decommissioned in Nigeria*, *occupational health and safety issues in building demolition processes in Nigeria*, *influential factors on the practice of building demolition in Nigeria*, *challenges facing the practice, and suggestions on ways to improve the practice.*

The importance of the findings is discussed in the conclusion section of this chapter; which connects it to the following chapter on developing a conceptual framework from the interpretation of the data.

5.2 The Research Participants

While in the original research design 21 participants were proposed to take part in the research (see table 5), it was only nineteen (19) participants that joined this study, and a total of sixteen (16) interviews were conducted. This was because four of the participants accepted to grant the interview as a group. All other fifteen (15) participants were interviewed individually. In the original research design, a quota of three (3) participants each from the seven stakeholder groups were to be interviewed, totalling 21. However, this was not in tune with the reality in the field for three reasons. In reality, the willingness and availability of the participants was not evenly distributed among the stakeholder groupings as proposed in section 4.7.2. On the other hand, some participants belonged to more than one group as shown in Table 6; implying that some of the participants played multiple roles in the industry that cut across the stake holder categories defined in this study. Additionally, the snowball technique adopted in this study (see Fig 21), does not allow the researcher to have control over who was to be recommended and what category s/he may belong. Moreover, qualitative data is considered adequate whenever saturation is achieved.

S/ N	Research Code	Occupation	Stakeholder Group	Experience (Years)	Projects (No)
1.	ENIE1	Marketer PT Contractor	Supply Chain/ Contractor	20	5
2.	ENIE2	Civil servant Engineer	Client Representative/ Consultant	26	9
3.	ENIE3	Architect Contractor Consultant	Contractor Consultant	14	4
4.	ENIE4	Architect Planner	Contractor Consultant	33	3
5.	ENIE5	Self-employed Bricklayer/ Foreman	Specialist Stakeholder	11	9
6.	ENIE6	Retired Civil Servant/ Architect Contractor Consultant Developer	Client Representative Consultant Contractor Owner User	40+	2+
7.	ENIE7	Group of four (4) Tinkers Marketers Contractors	Re-processors Marketers Contractors	Varies	6
8.	ENIE8	Academic Administrator	Client Representative	17	1
9.	ENIE9	Civil Servant/ Architect	Client Representative Consultant	25+	5

S/ N	Research Code	Occupation	Stakeholder Group	Experience (Years)	Projects (No)
10.	ENIE10	Tipper Driver	Specialist Stakeholder	11	2
11.	ENIE11	Civil Servant Architect Consultant Contractor	Client Representative Consultant Contractor	26	4
12.	ENIE12	Civil Servant Quantity Surveyor	Client Representative Consultant Contractor	10+	3+
13.	ENIE13	Civil Servant/ Architect Contractor	Client Representative	30	3
14.	ENIE14	Civil Servant/ Architect	Government Representative/ Development control	25	4
15.	ENIE15	Civil Engineer/ Contractor	Contractor	15	3
16.	ENIE16	Civil Servant/Planner	Government Representative/ Development control	26	4+

Table 6: The Research Participants/ Interviews

Each of the participants from the first set selected by the researcher was requested to recommend three other participants; nevertheless, only four of the participants were recommended by co-participant. For increased distribution of the participants across the stakeholder groups, twelve of the participants were directly identified by the researcher as shown in figure 21.

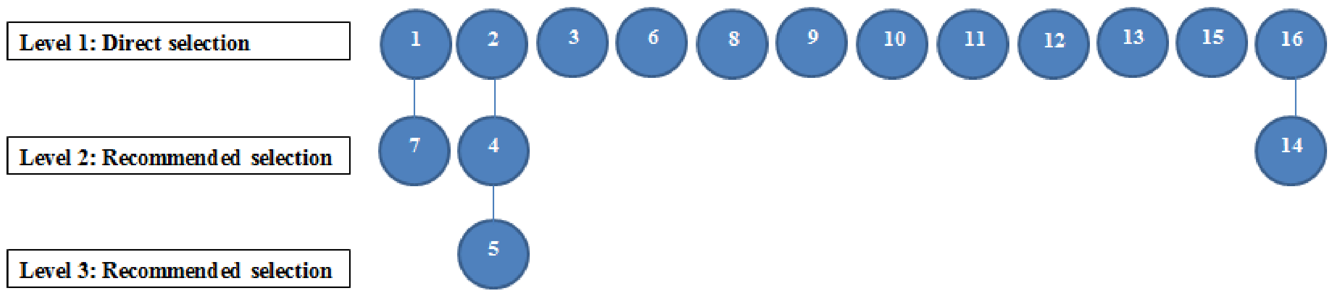


Figure 23: Research Participants Selection

5.3 The Interviews

Every participant was given an invitation to participate in the research, while stating the reasons s/he was selected, the research title, and purpose of the study. All the information s/he required to make a decision as to or not participate was contained in an attached participant information sheet. The information contained in the document, which was explained to each participant included the right to withdraw from the study at any time, how the interview will be conducted, and what happens to the data collected. The possible benefits and risks associated with participation in the research were stated and discussed with each participant. Other information is how the confidentiality of the research participants will be protected, the research organisation and information about the researcher.

The questions guide containing the nine questions was issued to the participants ahead of the date of the interview. Additionally, there was participation consent form that was signed by all the participants permitting recordings, pictures, or video to be taken where applicable. Appendix 5 is a sample of the invitation to participate, research information sheet, questions guide, and consent form.

All the documents were translated into the local Hausa language for three interviews involving six participants (appendix 6 is the translated Hausa version of the invitation to participate, research information sheet, questions guide, and consent form).

The interviews were conducted at venues and time most convenient for the interviewees and considered safe for the interviewer. Nonetheless, some of the interviews could not be completed at one session due to unavoidable interruptions from the busy schedules of the interviewees. The interviewer on the other hand, used a more detailed interviewer guide containing probing questions that were used as teasers to obtain more information from the interviewees and ensure that some predetermined themes are not omitted (appendix 7 is sample of the interviewer's guide).

5.4 The Analysis

The data was analysed using the thematic template analysis as discussed in section 4.9, nevertheless all variations in the responses of the interviewees were explored. The transcribed interviews were imported as cases into the Computer Aided Qualitative Data Analysis Software (CAQDAS) *QDA Miner Lite 1.4*. Hierarchical codes were created based on the themes and sub-themes of the interview, and newly discovered themes from the response of the participants. The codes were organised into groups according to the main topics (see Fig 22 & 23 below for the codes and grouping sample). Thereafter, all segments of the cases (transcribed interviews) were assigned to one or more codes relevant to the particular information. While some paragraphs and sentences led to new themes and codes, some of the priori and emerging themes were discarded for lost of relevance. Submission of all the participants on any particular theme is extracted in tabular format using the retrieval tool of the software (see Fig 24 below for example of code retrieval in tabular format). The extracted output was displayed for discussion and interpretation.

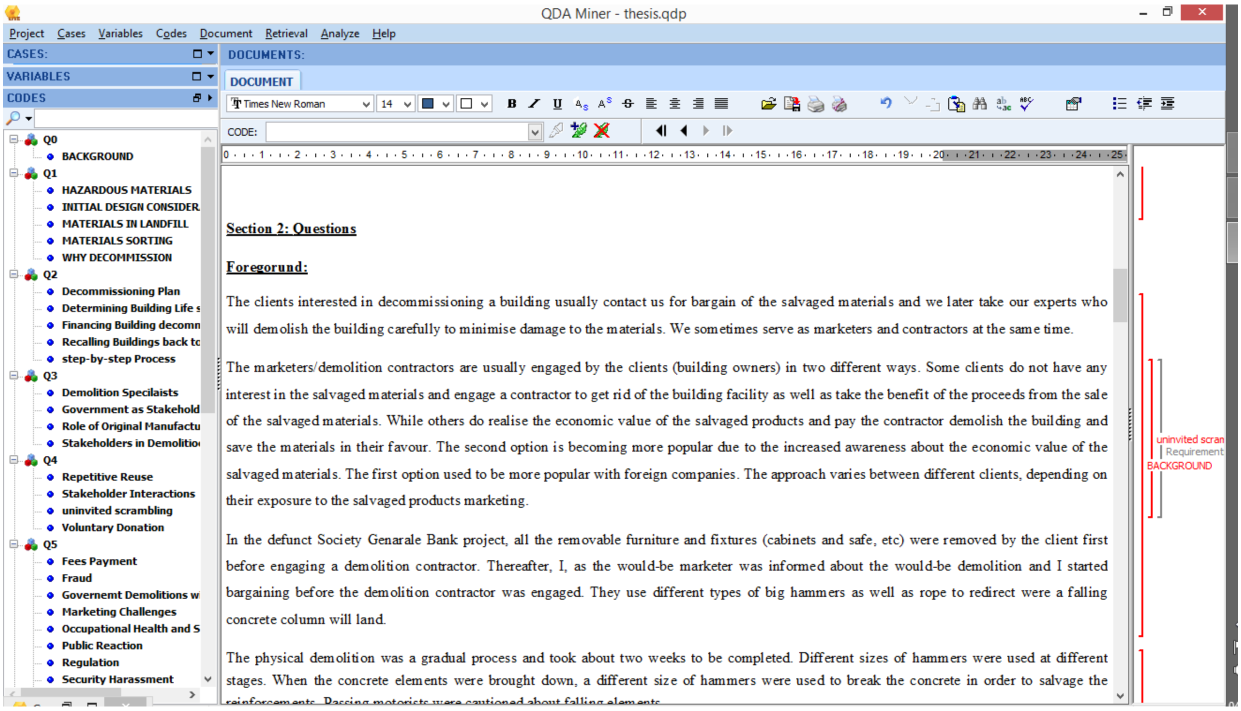


Figure 24- QDA Miner Lite Coding Interface 1

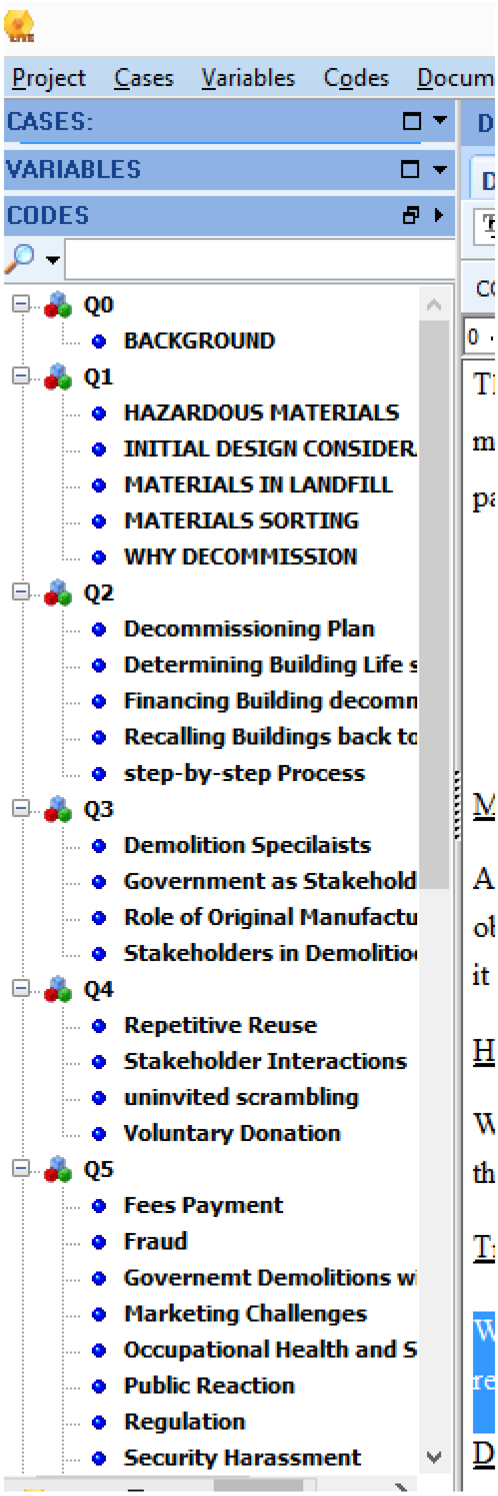
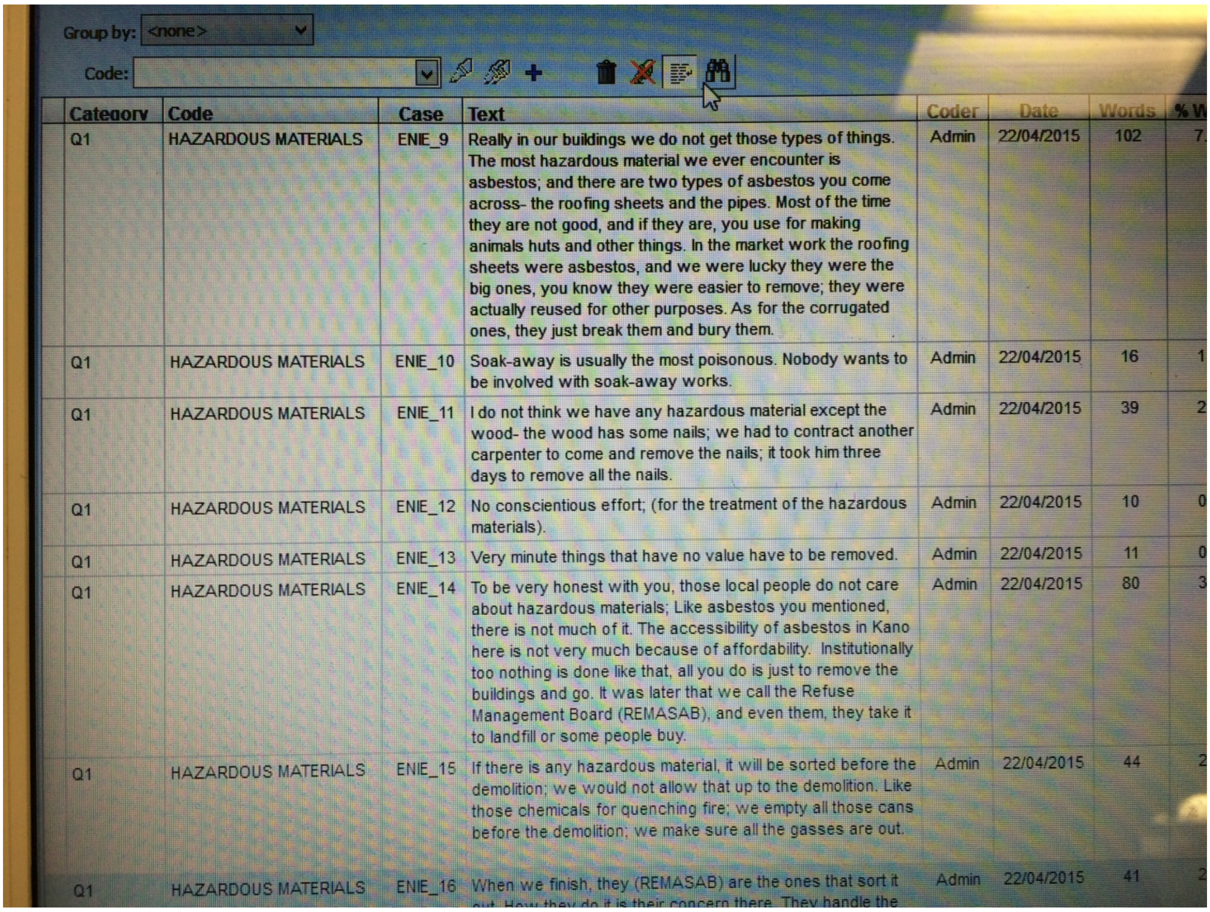


Figure 25: QDA Miner Coding Interface 2



Group by: <none>

Code:

Category	Code	Case	Text	Coder	Date	Words	% W
Q1	HAZARDOUS MATERIALS	ENIE_9	Really in our buildings we do not get those types of things. The most hazardous material we ever encounter is asbestos; and there are two types of asbestos you come across- the roofing sheets and the pipes. Most of the time they are not good, and if they are, you use for making animals huts and other things. In the market work the roofing sheets were asbestos, and we were lucky they were the big ones, you know they were easier to remove; they were actually reused for other purposes. As for the corrugated ones, they just break them and bury them.	Admin	22/04/2015	102	7.
Q1	HAZARDOUS MATERIALS	ENIE_10	Soak-away is usually the most poisonous. Nobody wants to be involved with soak-away works.	Admin	22/04/2015	16	1
Q1	HAZARDOUS MATERIALS	ENIE_11	I do not think we have any hazardous material except the wood- the wood has some nails; we had to contract another carpenter to come and remove the nails; it took him three days to remove all the nails.	Admin	22/04/2015	39	2
Q1	HAZARDOUS MATERIALS	ENIE_12	No conscientious effort; (for the treatment of the hazardous materials).	Admin	22/04/2015	10	0
Q1	HAZARDOUS MATERIALS	ENIE_13	Very minute things that have no value have to be removed.	Admin	22/04/2015	11	0
Q1	HAZARDOUS MATERIALS	ENIE_14	To be very honest with you, those local people do not care about hazardous materials; Like asbestos you mentioned, there is not much of it. The accessibility of asbestos in Kano here is not very much because of affordability. Institutionally too nothing is done like that, all you do is just to remove the buildings and go. It was later that we call the Refuse Management Board (REMASAB), and even them, they take it to landfill or some people buy.	Admin	22/04/2015	80	3
Q1	HAZARDOUS MATERIALS	ENIE_15	If there is any hazardous material, it will be sorted before the demolition; we would not allow that up to the demolition. Like those chemicals for quenching fire; we empty all those cans before the demolition; we make sure all the gasses are out.	Admin	22/04/2015	44	2
Q1	HAZARDOUS MATERIALS	ENIE_16	When we finish, they (REMASAB) are the ones that sort it out. How they do it is their concern there. They handle the	Admin	22/04/2015	41	2

Figure 26: Retrieval sample

5.5 Sustainablity in the Practices of Managing Building Demolition in Nigeria

This section discusses the sustainable practices of managing building demolition in Nigeria from the responses of the interviewees. This includes different ways of avoiding waste from building demolition, handling of materials when buildings are decommissioned, and the description of the step-by-step process of building decommissioning from real-life experience.

5.5.1 The Processes of Building Decommissioning

There is no consistent procedure for decommissioning a building that is generally applicable in all cases according to the response of the research participants. However, the only recurring feature among all the processes described is that removable elements such as roof, windows, plumbing and electrical fittings and fixtures are removed in different orders, before the building super structure is dismantled. The building skeleton is always removed from top to down for an obvious reason of safety (ENIE01; ENIE05; ENIE06). In one method, all moveable items are removed; thereafter, the roof, ceiling, electrical installations, and the doors and windows; subsequently, the building structure is flattened one element at a time starting from roof to foundation (ENIE01).

The decommissioning phases were given by an interviewee as starting from the stage a decision is made to withdraw the building from service. The second phase was given as communication of the decision to the concerned parties; and the third phase involves the physical demolition. The fifth phase was given as the phase for clearance of the materials (ENIE02).

There was a mention of the need for obtaining approval from the physical planning and health authorities before the physical demolition (ENIE03), however, it was not stated if this is what actually happens in reality or what should happen. And another participant that works with the physical planning agency refuted that permissions are obtained before a demolition project begins.

There was one unique description of the demolition process that attracts attention; it was an on-going demolition project that was simultaneously happening with a new construction on the same site at the same time. The walls of the new design were superimposed and interlaced in-between the yet to be demolished walls. It was after the new walls were built to grade level that the old walls were removed and the broken rubbles used for filling to make-up levels in-between the new walls. The architect of the project described the process thus- *"So we took physical measurement of what is on site, and designed an alternative structure and used (retained) part of the walls (existing) and erect some new ones* *(walls). We did not start demolishing immediately until after the foundation of the new walls was dug, and the walls erected up to the floor level in order to save cost. Then instead of buying laterite for filling to make up levels, we demolished the unwanted walls and used the rubbles for filling to make up levels, and that saved us a lot of costs"* (ENIE04).

Another approach that is different from the norm is when a building is demolished by Government to give way for infrastructural development or for enforcement of planning regulations. In the latter situation, three warnings are given to the owner to comply before the building is removed; while in the former, a financial compensation is paid to the property owner (ENIE14; ENIE16).

The common sustainable feature in all the descriptions of the process for demolition buildings is that, the building is deconstructed in a manner that maximises the opportunity for salvaging the materials for reuse or sale. As demonstrated in some cases, the materials may be utilised creatively on the same site for a new structure that replaces the existing. Extending the lifespan of materials is another of the sustainable practices for minimising wastes discussed in sections 2.5.2 and 2.6.4.

5.5.2 Materials sorting

Information on materials sorting was given in detail by one of the interviewees, thus: *"The materials were sorted according to its usefulness and handling requirements. Thus, materials are handled in different ways. Zinc roofing sheets for example are handled in a different way than asbestos, which breaks easily. Reinforced concrete elements are handle in two stages; after the concrete element is brought down, it is further broken down using smaller hammers to remove the reinforcement bars for onward sales to the salvaged products marketers. Damaged ceiling boards that cannot be reused for any purpose usually end-up in a landfill. The broken rubbles are sold at a cost, sometimes N 45, 000 per trip. Actually very few items may be taken to the refuse dump; even the* *ceiling boards were taken to the refuse dump because it was damaged by rainfall. Otherwise, it should have been marketable as it is useable for other purposes. Like the aluminium roofing sheets that are used for making cooking pots"* (ENIE01).

According this description, every single item is handled in different manner considered most suitable; and only on very rare occasions some few items are taken to the landfill when there is no any other way it could be reused.

Another interviewee (ENIE02) explained the role of the demolition contractors in the distribution of the salvaged materials to the different parties that may be interested in acquiring such items even at a cost price. He went further to introduce the issue of the uninvited members of the public that may intrude to take scramble for the salvaged items. The detail of the activities of this class of stakeholders was given in section 5.5.2.

The description of the process in demolition of buildings in a public university was slightly different. In this university, salvaged materials were carefully organised and handed over to a standing committee for asset disposal that auctions the items to the interested staff of the university (ENIE08; ENIE09). A similar approach is sometimes used by private clients whereby bids, sometimes unsolicited, are received from interested parties and sold to the best bidder (ENIE12). The materials may be grouped together according to functionality prior to sending invitation for bids (ENIE11). And sometimes right of first refusal may be given to the former occupants of the building, thereafter, bids may be accepted from outsiders (ENIE09).

Another approach in sorting materials is where the building owner is interested in reusing all or part of the salvaged materials in a new project on the same or different site. In such a case, the materials may be sorted according to its usability in the upcoming project (ENIE11).

When Government forcibly removes buildings, sorting of materials is handled in a slightly different way. While sometimes the owner may be allowed to repossess the salvaged materials, in many cases a Government agency responsible for refuse disposal is invited to clear the site (ENIE14; ENIE16). There is a proposal to make the violators of building regulations and victims of Government demolition to pay the cost of removal (ENIE14), however, removal by Government is currently executed by the relevant Government agency.

The different artisans that are engaged in erecting the structures are usually the same that are engaged to dismantle the elements relevant to their specialisation. For example, a carpenter will remove the roof, a plumber removes the plumbing fittings and fixtures, while an electrician handles the electrical installations (ENIE03; ENIE08; ENIE10). In the words of one of the participants, *"After fencing the property for safety purposes, a separate specialist was engaged for every item to be removed safely, like a plumber remove the plumbing fixtures, a carpenter bring down the roof with the rafters and other roof members in a sound condition"* (ENIE03).

5.5.3 Waste Generation

The respondents were asked to give account of materials that end in the landfill; the responses were largely in line with the presupposition that in Kano there is virtually zero demolition waste that may end in the landfill. One of the interviewees described the situation as- *"There [sic] are very negligible, including nails; nails are reusable or can be sold as scrap metal for recycling. Even timber that cannot be used in buildings can be used for firewood for cooking. This is yet another industry, there are people who specialise in that, getting timber from demolished building that cannot be used for anything but cooking. Everything is useable including* *the sand; you can use it for refilling or even in concrete work- i.e. as a recycled aggregate"* (ENIE06). From this description, there is the practice of reuse of materials in construction or other sectors, and the use of waste to energy, which is a recognised waste management technique.

Another participant described the situation thus- *"Actually very few items may be taken to the refuse dump; even the ceiling boards were taken to the refuse dump because it was damaged by rainfall. Otherwise, it should have been marketable as it is useable for other purposes. Like the aluminium roofing sheets that are used for making cooking pots"* (ENIE01).

In demolition projects involving public buildings, salvaged materials are not recognised officially. The contractors are officially paid to cart away the debris from site; nonetheless, this is not practical as members of the public come to scramble for it (ENIE02). There are instances whereby interested parties pay the contractors or the truck drivers for the rubbles to be delivered to their construction site. This practice is very popular among the locals that a term *"Kwashale"* in the native Hausa language is used to describe projects involving carting away the debris from site (ENIE10).

There is however exception to this norm, in rare occasions, some items may be taken to the landfill. The condition is that such material is considered to have no any useful application in construction or any other field. Celotex ceiling board damaged by rain from a leaking roof (ENIE01), or very small fragments of glass that could not be used anywhere are taken to the landfill (ENIE13), and asbestos roofing sheets that is usually difficult to save from breakage when it is removed (ENIE12; ENIE13). There was a case whereby the owner of the demolished building needed the rubbles for a new construction on the same site. However, due to lack of space to store the rubbles until it is needed, it had to be taken away at a cost (ENIE11). It was not clear if it was actually taken to the landfill or another developer acquired it.

5.5.5 The Role of the Specialists Stakeholders

Based on the general framework for construction industry stakeholders, a framework for building demolition was developed for the purpose of this study as described in section 4.7.2. The different stakeholders play various roles in handling the salvaged materials emerging from the process described in the preceding section.

The clients or building owners make the decision to decommission the buildings. Professionals like architects, engineers, quantity surveyors, and others are employed to provide services relevant to their field of study; whilst the contractors are employed to execute the physical demolition of the buildings. On the other hand, there are artisans and helpers that are employed by the contractors and sometimes directly by the client to work in the different aspect of the building demolition (ENIE12).

The marketers form another set of stakeholders that serve as middlemen who purchase the different salvaged materials for resale to the end-users that may reuse it in another building or for other purposes. This description of the general role of the stakeholders was based on the account of most of the interviewees. Nonetheless, there is another set of specialist stakeholder group that performs multiple roles and is essential for the operation of the building demolition industry, and their special role is discussed below.

The details on the activities of these specialist stakeholders were given in the accounts of an interviewee that was a project manager in two different Government projects. One of the projects was a police barrack that was replaced by a general hospital; and below is the account of what happened at the time of the demolition, verbatim.

"...Thereafter, we had to do the actual demolition; the demolition was supposed to be done sequentially. We planned to systematically remove the roofing materials- roofing sheets and the associated timber rafters, noggins and ceilings, and thereafter remove the components- doors, windows, electrical fittings, and the plumbing wares before touching the actual building structure. However, that was not perfectly achieved; because as I told you the client was Government and the structure to be demolished belongs to the Government.

When the community realised the structure was to be decommissioned, while the systematic demolition was starting, there was mass scramble, or rather mass participation by the people around, because of the need of the people to take the scraps and used them in their houses. A schedule that was to take about two weeks was finished in two days. We made a budget to pay for the decommissioning and package the salvaged materials aside and think of what to be done with it- rather to sell, auction, or give free to the people. I can assure you, we were unable to retrieve up to 5%; the people did the work, themselves! They removed all the rods (reinforcements), and all the components; the scene looked like one of the Nigerian festivals was going on there! The site became a market; a real market, people were removing roofing sheets, removing ceilings, packing it in different places, and in fact, there was a mini-market in the places. The needy people, those that wanted to use it (in personal properties) were packing it to their own homes; and some were packing it making stalls for sale.

After finishing with the components, our bulldozers that were in place to demolish the structures were not allowed to touch a single wall. Because the people came with their hand tools, and before you say anything, different parts of the buildings were flattened. What took them time to remove were the reinforcements of the structures, but even the *reinforcements, the pillars, the beams, were clearly cut by the people and you could find reinforcements all over.*

I was keen to follow these salvaged materials, and I found them in about three major markets in Kano. Let me tell you, almost in whole of the environment, you could hardly go to any street without finding one or two of the salvaged materials packed in different places. In fact, it was a mini funfair for about two weeks, I could tell you. The demolition exercise in not more than two or three days was finished; and the police barrack was really big; all the mounted troops of the police were there. We had to employ sizeable security personnel to keep peace there; all the other stakeholders in the project simply became observers, as we could not control anything, as per as that site was concerned. Any material you can think of, hand trucks (carriages), tippers, and head pans removed all the debris of the buildings, i.e. blocks, concrete debris, and whatever were all packed. As we provided the bulldozers, there were tippers, and loaders to pack the debris and possibly use it as hard-core filling, but the public did it for us. As I told you, everybody in the community was aware that the building belongs to the Government; and the notion is that what belongs to the Government is everybody's property, therefore belongs to all. The budget for decommissioning was significantly saved" (ENIE13).

While carrying over the experience from this project, some measures were taken to be in control on yet another project. Nevertheless, there were some successes recorded over what happened in the first project, as narrated by the same project manager who was at the same time a civil servant in charge of the project.

"Yes. Like I told you these two projects were hospitals; from our experience at 'Giginyu' quarters project, we made a plan on which way we should work to avoid the repeat of what happened. It was based on that plan that we were somehow able to achieve some orderliness in it and a little bit of sanity. We were able to execute the project at a more secured

condition. It was not a very comprehensive plan, but somehow assisted us not to have encountered the same experience; it was a guide. The sequence I told you, we were able to implement to a certain level.

At the Zoo Road project, what we did was to provide adequate security; and we systematically removed all the items of roof and related elements. We did not allow the public to know that we were completely demolishing the structure. We made it appear that we were going to upgrade it. At the first stage, we did not touch any superstructure; we made sure that all roof and related items were removed and kept aside. Like everybody knows if you are making alteration in your homes the electrical items may not be in place, we were able to carefully, remove all the electrical and plumbing materials and packed them in a store. It was part of the plan to have a store and keep the items in the store; we made everybody believe that the items were to be reused in the same project. We also removed all the doors and windows and packed them in the store. Then we came to the superstructure; then it was at that level that we lost control and the public took over. Despite that, with the help of the security, we were able to save some reinforcements. The difference between the two sites is that at the Zoo road project the structures were in a fenced site. It was a secured site and that gave us some advantages. Still when people realised we were demolishing, they remembered the "Giginyu" case, and size of the crowd could not be controlled by the security. Therefore, as we were removing reinforcement, the public too were removing the reinforcement; we were competing with the public. We planned to use the rubbles in making up levels on the same site; unfortunately, in the night people removed most of it. It was however a much better than the 'Giginyu' case" (ENIE13).

The group of "specialist stakeholders" referred to as *"Yangwangwan* in the local Hausa language, are specialist actors that drive the operations of the salvaged building materials in three different roles. The first category of the “Yangwangwan are traders that buy and sale the salvaged materials in the locally well-known salvaged materials markets located in different locations in the Kano metropolis (ENIE01; ENIE04; ENIE14). The largest and probably the most popular of such markets that is equally exclusive in salvaged materials is the Kingsway market at Murtala Mohammed Way in *Sabon-gari* Township. Other markets are located at France Road, *Kofar Ruwa*, *Tarauni* and *Sharada*. Nonetheless, the stocks holding of the merchandise in these markets is equally large. While these markets may be the best known, the list is not exhaustive, as there are other smaller salvaged materials markets spread all over the city of Kano metropolis (ENIE01; ENIE04; ENIE14).

While the first category of the *“Yangwangwan* are basically traders that buy and sell the salvaged materials, the second category that referred to themselves as tinkers reprocessed the salvaged materials into different products before it is resold in the market (ENIE07). Some of these products include cooking pots, kerosene stoves, coal stoves, bread moulds, poultry feeder, a freezer, (Fig 27 to 32).

Figure 27: Cooking pot made from salvaged aluminium roofing sheet

Figure 28: Kerosene stove partly made from salvaged aluminium roofing sheet

Figure 29: Coal stove made from combination of salvaged roofing sheets

Figure 30: A freezer made from combination of salvaged materials

Figure 31: Poultry feeder from salvaged materials

Figure 32: Cooking pots, bread moulds, work in progress

The third category of *"Yangwangwan* (Fig 33 to 34) are the self-employed scavengers that may get access to a demolition site to save as much of any valuable material including breaking concrete elements to salvage the reinforcements, (ENIE02; ENIE14). This is rather a recent development and their activities may probably be motivated by unemployment and poverty and sometimes involves a lot of illegality as in the stories narrated by (ENIE13).

Figure 33: Self-employed *Dangwangwan* breaking concrete to salvage reinforcements for sale

Figure 34: Salvaged reinforcements from a broken concrete

It is noteworthy that there is no clear distinction in the functions of the three groups of *"Yangwangwan* as traders, tinkers or scavengers as explained by some of the interviewees; the traders and tinkers may also work as contractors, while the scavengers sometimes operate as traders depending on the opportunity (ENIE01; ENIE07). However, what is common about the three types of *"yangwangwan* is their specialisation as full-time professionals that make a living out of the salvaged materials from building demolition. The activities of this group may be attributed to the virtually zero demolition waste in the larger society.

While the activities of external stakeholders such as the non-governmental organisations (NGOs) was not reported by any of the participants, the Government features as owner of the public buildings demolition projects and demolished illegal structures. In the words of one of the participants: *"Government as stakeholder, Government only get involved in a demolition project when they are invited. Otherwise, they do not care and do not play any role. Where the Government happened to demolish some illegal structures, they usually leave the remains unattended"* (ENIE01). This suggests that the Government do not play any role as external stakeholder or regulator of activities in demolition.

Most of the interviewees agree that the original materials manufacturers do not play any role comparable to the aircraft and the automobile industry discussed in sections 3.2 and 3.3. However the steel rolling and aluminium smelter firms were reported to purchase scrap materials from the *"yangwangwan* for recycling into reinforcement (ENIE07).

The overall organisation of the different operators in the building demolition industry as described in this section suggests that, though developed without any deliberate effort, the industry is purposely differentiated to facilitate the sustainable management of materials to produce zero wastes. The structure and operations of the stakeholders exhibits the characteristics of the natural ecological systems whereby the organisms interact to produce zero material waste as discussed in section 3.7.

5.5.6 Finance and Profitability in Building Decommissioning Process in Nigeria.

Most of the participants reported that it is the building owner who is usually responsible for financing the demolition of the buildings. Nevertheless, the labour for the removal and sorting in some other cases was reported to be paid by the buyers who get the items removed according to their specification (ENIE01; ENIE12).

A professional who specialised as a salvaged materials marketer as well as working as a part-time contractor reported: *"Building decommissioning is usually financed by the property owner in two ways; either the contractor is paid in cash by the client to demolish the building, or the contractor is paid in kind with the salvaged materials. In the instance were the property owner decided to declare the salvaged materials that may be realised from the building for free, then we demolish the building for him at no cost and make reasonable profit from it. It is very profitable if the property owner has no interest in the materials. I do not mind if it is ten-storey building, I can demolish for a client at no cost and as I am sure of making profit from the salvaged materials. Sometimes the salvaged materials can be of high quality that is no longer available in the market. For instance, the roofing sheets I am using in my personal house is a high quality steel product salvaged from a bank building. It was used in the bank building for 50 years and I used it in my house for ten years now, and it is still in a very sound condition that can last many more years. Some of the materials like steel go for recycling as the manufacturers use 70-80% local raw materials"* (ENIE01).

On the account of another participant (ENIE11), *"In our own case here, the materials we sold to the "yangwagwan", we used the amount to settle all the cost of the demolition but without surplus. I remember another project in our ministry (Governement Department); the commissioner directed me to demolish some buildings (administrative block) in front of the commissioner's office. I asked for the money to demolish the structures; and he told me to sell the scraps to "yan gwangwn" and finance the demolition. But in Dawaki Road we had some surplus; like two third of the money (from sales of the salvaged materials) was used to pay for the demolition and one third was the surplus*". The proceeds from the sales of the salvaged materials funds the demolition and sometimes with some surplus.

On the other hand it was reported that on Government projects there is always a budget for demolition in the preliminary items of the bill of quantities (ENIE02; ENIE13). The only exception to this pattern is when the Government demolishes a building contravening building regulations; in such instances, it is the Government not the owners pay for the demolition (ENIE14; ENIE16).

In contrast to the practice in the nuclear sector whereby special plans are made for saving money to finance the decommissioning of the facility (see section 3.6), the above accounts revealed that demolition of buildings in Nigeria is self-financed, sometimes with some profits.

5.5.6.1 Marketability of the Salvaged Materials

Decommissioned airplanes, ships, or nuclear power plants may be challenging for resale and reuse as discussed in sections 3.3, 3.4, and 3.6; in contrast, salvaged building materials in Nigeria are on demand, probably due to the socio-economic and other factors to be discussed in section 5.8. According to some of the participants, *"in Nigeria everything is marketable"* (ENIE15), *"As per as I know it, is hardly [sic] you see a* *product that is not needed from one group to another*", (ENIE16), and *"No, it is just like a cow in Africa; everything is useful; every little thing is useful!"* (ENIE09). These are some of the remarks of the interviewees; people find a use for virtually everything; from the windows, to rubbles, pieces of metals and broken glasses; pieces of tiles that were used as skirting are available in the market for resale as described by (ENIE01), *"Mhm", actually no material is difficult to sale. You know people wanted [sic] to build. So everything is marketable. Look at this, skirting buyers are coming for it. People come to ask for the broken tiles. The bags in my stocks are full and more in quantity than others, so I know people will come for the remaining ones. I got it from a decommissioned building*". These materials may go back into another building or any other purpose including use as a raw material for reproducing products for use in other sectors.

Increased public awareness about the economic value of the salvaged building materials might have influenced the surge in the attention it attracts. One of the marketers interviewed admitted that in the past, they go out in search of the salvaged materials; nonetheless, nowadays people sometimes bring an offer to them to the market (ENIE01).

Notwithstanding, there are a few occasions where some category of items may sometimes become difficult to resell in the market. These include, some obsolete electrical fittings (ENIE11), and damaged ceiling boards (ENIE01).

Thus, this section shows that the reverse logistics for reclaiming materials is made simple and more efficient in the demolition process by the marketability of the salvaged materials.

5.5.6.2 Repetitive Reuse

Some clients occasionally reuse the salvaged materials for a new project on the same or different site as indicated by the research participants. In this situation, the owner becomes the end-user at the same time. On one occasion, the rubbles were used to make up levels for the new project on the same site *“However, the rubble was rather [sic] used 100% on the site for filling and levelling with some additional laterite imported to make up the ground levels for surface water drainage* (ENIE03). On another occasion concrete blocks were saved and reused to construct a guesthouse, *“Some of the concrete blocks we salvaged were solid core and very strong. We reused it to construct a guesthouse”.* On another project participated by the same research participant the timbers were saved and reused as recounted *“only the timber was salvaged for reuse in the same building, while the other items were salvaged for reuse in other buildings”* (ENIE11).

In another occasion, a participant working on a project as a consultant was mandated to advise the client on the materials that may be reusable on a new construction project to replace the decommissioned building (ENIE11). Likewise, on another construction project, the demolition and construction of the new structure were simultaneously undertaken with the new walls interlaced between the old to be demolished later (see section 5.5.1).

This practice of reusing the salvaged materials by the clients is recommendable as it extends the lifecycle of the materials which is considered a sustainable practice as discussed in sections 2.5.2 and 2.6.4.

5.5.7 Avoiding Waste

The most sustainable waste management technique is avoiding waste; which can be achieved in different methods as discussed in section 2.5. These include prolonging the lifespan of buildings and designing out waste from the initial planning stage and its implication on the practice of end-of-life management of buildings in Nigeria is discussed below.

5.5.7.1 Defining the Lifespan of Buildings

Some of the participants reported that the lifespan of buildings in Kano is simply determined by the physical condition of the building and the perceived risk of a failure associated with dilapidated structures (ENIE08; ENIE11; ENIE12). *"We just look at the physical state. If it is dangerous, is life threatening*" (ENIE08). This indicates that the lifespan of a building is prolonged as long as the building is safe, which helps in avoiding waste and is a recommendable practice in line with the principles of sustainability.

In other instances, buildings meant to be demolished are recalled back to service; and this mostly involves public buildings planned to be demolished however, the decision was reversed for some reasons (ENIE01; ENIE03; ENIE13). This is similar to the practice in aircraft industry that are sometimes temporarily suspended from service discussed in section 3.3.

Prolonging the lifespan of buildings in the two approaches is a method of avoiding waste, which is in compliance with the sustainable waste management practices. Two other methods of prolonging the lifespan of buildings and the reusability of the building materials are initial design considerations and decommissioning plans, which are however not common practices in Nigeria as reported by nine of the participants.

5.6 Occupational Health and safety in Building Demolition: The Nigerian Experience.

5.6.1 Overview of the Occupational Health and safety in Construction

Statistics from around the world suggests that construction industry is the most dangerous and probably responsible for more fatal and non-fatal occupational accidents than any other industry. A 1998 study in Geneva revealed that 43% of construction workers develop permanent impairment at the age of sixty-five (Lingard & Rowlinson, 2005). While in the UK the Egan report *“rethinking construction (1998)”* revealed that construction is the second worst industry in terms of health and safety (Howarth & Watson, 2009). This was attributed to the nature of construction as a project-based activity whereby an intricate combination of a variety of crafts and tasks are engaged mostly on a short-term basis. Contempt for authority and regulations, corruption and malpractices are some of the other attributes of the construction industry (Lingard & Rowlinson, 2005).

This in turn makes occupational health and safety (OHS) measures less effective than in other industries. While it was believed that accidents are chance events that cannot be prevented, evidences suggest that accidents in the construction industry are similar reoccurring types of incidences involving falls, power, and hand tools (Lingard & Rowlinson, 2005). For instance, 46% of fatality in the UK construction industry in 1996-2003 was caused by falls from height, 17% by moving objects, and 14% by moving vehicles (Howarth & Watson, 2009, p. 19); therefore, the likely source of the problems is known, however, unmatched in action. This is attributed to the conservative nature of the construction industry that is resistant to change in operational methods and learning from experience; and directly or indirectly affects the OHS in construction. The separation of design and construction, competitive tendering, the plethora of small businesses, subcontracting, and emphasis on contractual relationships are common characteristics of the construction industry that delimit the considerations for safety issues (Lingard & Rowlinson, 2005).

With autonomous working and subcontracting system, the roles of client and designer, and the planning of the construction process can influence health and safety issues in construction. Regulation of subcontractors is very vital to health and safety in construction, as any improvement in the performance of the general contractor is greatly affected by the contributions of the subcontractors. Safety considerations begin at the design stage, with benefits at construction, maintenance, and operation phases. This brings the designer and client to share responsibility with the general contractor that was traditionally laden with all liabilities. Both client and designer can obtain guidance from the codes of practice and standards that provide performance based best practices. Furthermore, corporate organisations are continually under pressure of taking social responsibility including health and safety issues (Lingard & Rowlinson, 2005).

In the UK, a campaign to improve health and safety issues in construction began in 1999 with the “Revitalising Health and Safety” initiative. The initiative sought to minimise fatalities and major injuries, loss of working days, and work-related ill health (Howarth & Watson, 2009, p. 20). On the other hand, there are EU regulations and directives, acts of parliaments, and approved code of practices (ACOPs) that affect construction health and safety requirements in the UK. The EU “framework directive 89/391/EEC” was adopted in June 1989 to prevent occupational risks, protect safety and health, and provide training for workers. The EU Temporary or Mobile Sites Directive 92/57/EEC was implemented in the UK by the Construction (Design and Management) Regulations 1994 replaced by Construction (Design and Management) Regulations 2007 (CDM2007) to improve the health and safety management on construction sites. The Health and Safety at Work etc Act 1974 (HSWA) was a statutory law that outlines the general duties of employers and employees to the members of the public and to each other. Approved codes of practices (ACOPs) may not be legally binding, however, it complements the HSWA by providing practical guidance for compliance. The HSWA further formed and authorised the Health and Safety Commission (HSC), and the Health and Safety Executive (HSE) to enforce workplace health and safety in the UK. Important health and safety regulations in the UK are highlighted in the table 7.0 below adopted from (Howarth & Watson, 2009).

S/N	Date	Legislation
	1974	Health and Safety at Work etc
	1981	Health and Safety (First Aid) Regulations
	1987	Control over Asbestos at Work Regulations- Revised 2002
	1988	Control of Substances Hazardous to Health (COSHH) – Amended1994 and 1999
	1989	Noise at Work Regulations- Amended 2005
	1992	Workplace (Health, Safety and Welfare) Regulations
	1992	Management of Health and Safety at Work Regulations- Revised 1999
	1992	Personal Protective Equipment at Work Regulations
	1996	Manual Handling Operations Regulations
	1994	Construction (Design and Management) Regulations- Replaced by CDM2007
	1995	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)
	1996	The Construction (Health, Safety and Welfare) Regulations –Revoked and replaced by CDM2007
	2005	Work at Height Regulations
	2007	Construction (Design and Management) Regulations 2007

Table 7: UK Construction health and safety legislations adopted from (Howarth & Watson, 2009).

The legislations on health and safety in construction do not separate demolition from the other types of construction activities. Nevertheless, refurbishments involving demolition and structural stability constitute a unique case, more especially if its contribution to the statistics of construction fatalities is considered. This is the subject of the research report 204 conducted by Loughborough University and Milan Polytechnic in 2004.

5.6.2 Health and safety in refurbishment involving demolition and structural instability

In the research report for health and safety in refurbishment involving demolition and structural instability, 40.6% of construction fatalities were attributed to refurbishment works in the UK (Anumba, 2004, p. 1). The majority of these accidents are due to the collapse of the whole or part of the structure unexpectedly. This is notwithstanding the provisions of British Standard 6187 “code of practice for demolition” which suggested methods and techniques for demolition.

Demolition of buildings constitutes a complete project cycle with design, planning, and execution phases. Procurement of demolition is equally comparable to that of construction, nevertheless, in demolition, the traditional procurement method – main contractor and sub-contractors, is realised to be more effective than construction management, design and build, and advanced packages (Anumba, 2004).

Accident reports by the HSE inspectors identified the non-provision of temporary support, oversight of risk assessment, preliminary site and structural surveys at design stage, and poor planning as the leading issues associated with accidental collapse of buildings. Other reasons include absence of demolition method statement and inadequate supervision. Subsequently, design and planning, plant and equipment selection, workforce pre-qualification and supervision, communication and education were identified as issues to be addressed in building refurbishment projects.

All principal stakeholders involved have a duty to perform in implementing health and safety issues in building refurbishment, which may include demolition. Specifically, the client, planning supervisor, architect, structural engineer, contractor or demolition sub-contractor, worker, and the proposed temporary structures coordinator will play particular roles. The contributions of these parties will be needed in both the design and implementation stages.

5.6.3 Occupational Health and safety in Construction in Nigeria.

The picture of the occupational health and safety in the Nigerian construction sector was described by Idoro (2008) in his writing on the correlation of the management efforts and performance among the Nigerian construction firms. While the construction industry may be among the most hazardous worldwide, the scenario in the developing countries is made worst by absence or inadequate legislations, negative attitude, and dearth of records. He reported that the tendency of the Nigerian Governments in such situations is to localise the UK or USA legislations on the concerned issues, nevertheless, on health and safety in construction, there was never such an effort from independence in 1960 to the publication time (Idoro, 2008). The Nigerian Factory Act of 1990 is modelled on the British Factory Act of 1961 to create a Nigerian version. However, the Occupation Safety and Health Act of 1970 originated from the USA. On the other hand, the Control of Substances Hazardous to Health Regulation of 1988, the personal Protective Equipment at Work Regulations of 1992, the Management of Health and Safety at Work Regulations of 1999, the Manual Handling Operations Regulations of 1992, and the Construction (Design and Management) regulations are from the UK without any attempt to customised the Nigerian versions (Idoro, 2008).

S/N	Date	Legislation
	1999	The Management of Health and Safety at Work Regulations
	1994	Construction (Design and Management) Regulations
	1992	The Manual Handling Operations Regulations
	1990	The Nigerian Factory Act
	1970	Occupation Safety and Health Act 1970
	1988	Control of Substances Hazardous to Health Regulation
	1992	The personal Protective Equipment at Work Regulations

Table 8: Nigerian Legislations on Health and safety relevant to Construction adopted from (Idoro, 2008).

The Factory Act is sometimes extended to cover other sectors like the construction (National Occupational Safety and Health Information Centre, 2006; Rotimi Williams, ND; Williams, 2010), and health (Kalejaiye, 2013). Nevertheless, the implementation mechanisms established by Government paid more attention to factories, while the construction industry was left uncensored without monitoring and punishment for non-compliance (Idoro, 2008). Consequently, the stakeholders ignored the provisions for health and safety and record keeping becomes at best haphazard and in most cases non-existent. Idoro (2008) observed that studies that utilised accident data from construction sites may not be reliable as the stakeholders' willingness to keep record or disclose information is impaired as it is legally optional and the image of the company may be affected negatively. He further suggested the use of the proactive efforts by the management of the construction firms for the assessment of performance in matters regarding health and safety.

While the above overview discusses the Nigerian construction industry in general, in the following section the state of affairs in OHS in demolition projects will be examined.

5.6.4 Health and Safety Involving Demolition in Nigeria.

According to the accounts of some of the participants, the situation report on occupational health and safety (OHS) in building demolition projects in Nigeria is not much different from that of the general Nigerian construction industry as written by Idoro (2008). A salvaged materials marketer who sometimes works as a contractor described the OHS in demolition in Kano as problematic. Workers do not have any formal training and are not conscientious of OHS. Even though, he mentioned only one case; he believes there might be so many deaths from demolition activities, mostly caused by falls from height that were never reported and recorded (ENIE01). Some other participants concurred with this assertion describing the OHS in demolition as the last thing in the mind of Nigerians who consider financial gains to be a more important priority (ENIE14; ENIE15). Among some people, it is believed that OHS precautions may only be required when dealing with multi-storey buildings (ENIE06). There seems to be no coordinated action; everybody is left to operate on his own (ENIE10); Nigerians were believed to take so many things for granted, including OHS (ENIE12). On the extreme is the account of an interviewee who has been an actor in the Nigerian construction industry in several capacities; he narrated as follows: *“There is not much consideration given to health and safety in our construction fields. There is a story of a project where I manage the funds, and I paid for the emergency medical treatment of an accident victim on the site. Unfortunately, the client was furious and strongly objected about such action. There are examples of constructions where the contractors completely ignore health and safety issues completely despite a budgetary provision in the contract for that purpose. When the Government is alerted on such issues, an action will definitely be taken”* (ENIE02).

On the other side, there were accounts of positive efforts to take some actions on OHS in demolition works. Proactive broadcast to neighbours who might be affected by the demolition, and the use of hand gloves were reported (ENIE08), as well as facial masks, helmets, and safety boots (ENIE10). The demolition squad employed by the development control authority supposedly use helmets, boots, jackets and whistles, with the presence of a standby medical team (ENIE16). Provision of first aid boxes (ENIE07), and proactive liaison with nearby hospital were equally reported (ENIE08; ENIE09), as in the words of (ENIE02): “There is usually a first aid box on site, and a medical personnel within reach is identified”.

5.6.4.1 Treatment of Accidents Victims

The treatment of accident victims is equally a mixed experience, with both negative and positive stories. An interviewee (ENIE05) stated that on one project the client paid the bills for the medical treatment of a worker that broke his leg, including some additional reparation. On another occasion, the project manager of a demolition work personally settled the medical bills of two different accident incidences out of compassion. The client who sympathized did not make any financial contribution. However, there are more stories on the reverse side than on the other side.

The worse scenarios are when a victim is left on his own, without assistance from anywhere as revealed by (ENIE05), and (ENIE10). A story of a comrade who became a victim was narrated thus: *“in most cases, you just have to help yourselves. Many of the clients do not do anything. A carpenter colleague fell down and got a serious injury, but the building owner only gave five thousand naira (less than £18 GBP) to the victim and thereafter did not do anymore. A relative of the victim had to pay for the medical bills”* (ENIE05).

Another trend is the practice among the self-employed *“Yangwangwan* (Tinkers) who specialised in reprocessing of the salvaged materials from decommissioned buildings. They sometimes use hand gloves as a precautionary measure; however, treatment of injuries is done through a traditional method. In an interview with the group of four participants, a traditional method of treatment of injuries was apparently more popular among them. They expressed confidence in the efficacy of the spider curve waves in the treatment of wounds! They believe it does not only stop bleeding immediately, it additionally works as an anti-tetanus immunisation. Even though injuries are not uncommon in their profession, they claimed to have zero record of tetanus incidence (ENIE07). This claim is a subject of another discussion beyond the scope of this study, more especially, with the increased popularity of the concept of biomimicry. An effective cure for cancer used by chimpanzees was discovered in addition to so many other technological innovations inspired by nature itself (Benyus, 1997). It may not therefore be dismissed that spider curve waves may have some medicinal properties, and whether it should be acceptable as a treatment is yet another discourse beyond the scope of this study.

Whereas the *“Yangwangwan”* - tinkers were satisfied with the traditional treatment, half of the other interviewees expressed some dissatisfaction with the manner accident victims are treated. This is in the view of the uncoordinated and haphazard way the OHS is handled. Responsibilities are not well spelt-out with accident victims left at the mercy of any willing and compassionate party. One of the research participants described the situation as:

“This thing (OHS) has never been taken seriously in this part of the country; ... The client may pay for the medical bills on humanitarian grounds but there is no obligation” (ENIE11). According to one

participant: *“I never had an inspector coming to a building introducing himself as coming for safety”*.

This is an imperative for a comprehensive policy including a legislation that spelt-out responsibility for all parties, as well as the need for an enforcement agency.

5.6.4.2 Legislation on Occupational Health and Safety (OHS) in Nigeria.

None of the participants was able to cite any particular legislation on OHS in the process of building demolition. Many responded with the phrase- “I am not aware” or “not aware” or simply “No” (ENIE01; ENIE04; ENIE05; ENIE06; ENIE10; ENIE11; ENIE14). Four participants interviewed as a group claimed that the Government does not play any regulatory role in their profession (ENIE07). Notwithstanding, there were some clues to the possibility of some efforts to regulate demolition activities by the Government; and these efforts may include OHS. A participant revealed how he an environmental officer approached to ask if there was an approval for the demolition activity. He presented an approval from the KNUPDA (Kano Urban Planning and Development Authority). Thereafter, they told him, there was a need for another approval from their office in order to demolish, and that was the last he saw of them (ENIE12). Another interviewee suggested that there may be a work in progress to make a legislation on OHS in one of the neighbouring states (administrative regions) (ENIE03).

Three participants (ENIE09; ENIE15; ENIE16) claimed awareness about some legislation related to OHS. One speculated that Nigeria may have a law on asbestos, while others mentioned that there may be no law specific to demolition, but the law on insurance includes a section on hazards, and covers compensation for lost of life or body parts, however, none could cite any legislation. This is despite the display of safety boots provided by a contractor, as it was not established if the contractor was acting on his discretion or compelled by law. More especially, as demonstrated previously, it is discretion rather than enforceable legal requirement that guide OHS responsibilities in the industry. Nevertheless, laws without awareness and implementation strategy would not be effective. One of the actions needed to assist in developing an implementation strategy is keeping records and statistics.

5.6.4.3 Attitudes to Records and Statistics of Accidents in Building Demolition.

With the exception of one participant who claimed that he came across a journal whereby it was reported that the federal Government started to keep records of accidents on construction sites, no other participant reported that records and statistics of accidents are kept at all. (ENIE10), with some degree of uncertainty remarked: *"I think they do it in the hospitals"*; in the same way (ENIE12) remarked *"you may have such records may be in some hospitals"*. Otherwise, most of the other participants (over 80%) accepted it as a lapse; moreover, (ENIE14) argued that the hospitals are not likely to care about the cause of an accident while treating patients. In his words *"We never had that. To be frank with you, there is none. I wanted to take some study some years back on fire incidences, you know what? I met a blank wall. Somebody told me that the Government might think you are trying to pin somebody. I just wanted to know the causes of the fire. So, the issue of anybody falling from height will never be reported. Probably in the hospitals; the hospital may not even look at the cause, from construction or not".* This participant is trying to point at the apathy of the Government officials towards keeping or disclosing such records. Some might think it is a move to attack the Government by rival political parties. This is not surprising, as the author had the same experience while collecting data for this study.

A follow-up interview with a medical officer that works in the accident and emergency unit of the largest hospital in Kano showed that generic causes of accidents are recorded on patients' diagnosis and prescription forms; however, no statistics are further extracted from such records. The generic implies classifications like construction, road accidents among others, while specific causes of accidents like demolition, falls from height, etc are not recorded.

5.6.5 Discussion.

The findings of this study imply that the situation of the occupational health and safety in demolition projects in Nigeria is not much different from the findings in a similar study related to the role of managers on occupational health and safety as it correlates with the performance of the Nigeria construction industry in general by Idoro (2008). Provisions for occupational health and safety in demolition are poorly coordinated, with minimal implementation strategy. Low-level awareness of OHS among the actors in the industry was pronounced. There are inadequate arrangements for treatment of accident victims, who are sometimes left at the mercy of the compassion of any stakeholder in the project. At worst, the victims are left to fend for themselves. However, there is no evidence to suggest that there is a definitive causal relationship between the use of traditional medicine in the treatment of injuries and lack of adequate medical care facilities or awareness.

Even though the relevance of some legislation like insurance to OHS were illustrated by the participants, specific legislations or any regulatory instrument on OHS in construction or demolition do not exist. Absence of a comprehensive legal provision will hinder any attempt to create an implementation mechanism. It is therefore not a surprise if the implementation strategy is discovered inadequate. On the other hand, the culture of keeping records and statistics should be in the frontline of any implementation strategy. The responses of the participants show dissatisfaction with the role of OHS in demolition, and there was an outright call for Government's action.

5.7 The Stimulant Factors on the Practice of End-of-life Management of Buildings in Nigeria.

A number of factors were identified as influencing the emergence and prevalence of the practices associated with management of building decommissioning in Nigeria. These include the economic, cultural, public building model, foreign influences, and professionals' advices as will be discussed in the following sections.

5.7.1 Economy

In more than half of the cases discussed, performance of the national economy was considered by the participants to be an important factor that influences the practice of the end-of-life management of buildings in Nigeria. While some of the participants casually mentioned the performance of the national economy (ENIE03; ENIE07; ENIE08; ENIE09; ENIE16), there was a striking recurrence of phrases by the interviewees referring to the economy such as: *"Of course the economy"; "the more affluent the people are the more they want bigger things"; "the more they want luxury"*. The same sentiment was echoed by ENIE16 , when he stated, *"if the economy is doing well we have more decommissioning taking place. Like what I noticed in 2010, I had more decommissioning than any other year. When the economy is booming people will want a change in service"*.

A variant of such statement was echoed by another participant when he mentioned, *"People buy used materials because the national economy is not doing very well. I believe if the economy is booming, nobody will buy second-hand materials. On the other hand, if the economy is doing well, more people will need to demolish"*.

However, these statements carry confusing messages. In the first part, it implies when the economy is performing well, people may not have to use salvaged materials, while on the other part it mentions that when the economy is good, more people will demolish. Nonetheless, the two can be reconciled in the sense that when the economy is booming more people will get richer and will need to demolish properties for upgrades or change of purpose. On the other hand, if the socio-economic structure of the citizens minimises the gap between the rich and the poor, then less people may be interested in purchasing salvaged materials in place of the new ones. It is relevant at this point to refer to the socio-economic structure in Nigeria - a wealthy country that is polarised, with super rich upper class and extremely poor lower class and virtually no middle class (Aigbokhan, 2000; Aiyedogbon & Ohwofasa, 2012). Therefore, when the rich demolish, the lower class build from the salvaged materials, thus creating a balanced system that saves the physical environment from unwanted wastes.

Furthermore, majority of the participants corroborated the economic theory in explaining the emergence of the practice by associating it with the changes in the performance of the national economy (ENIE03). One participant argued that in the past twenty years back, the practice was not popular. In his own words, *"Before, twenty years back it does not happen like this; I think the economy is really changing things. People are now looking for anyway I can get employed, I can now do that. Before it was done at a very lower level; you can hardly see anybody breaking concrete and taking rods; no! But now it is the fastest thing to be done. I think in those days some of the things you look at was the roofing sheets and timber; and may be doors and windows*" (ENIE14). This statement suggests unemployment as another factor that contributes to the emergence of this trade. In this case, the practice serves dual purposes of protecting the environment by reusing materials as well as creating jobs.

In another interview with the group of four respondents, they added a business case to the economic stimulant of the practice. These group of interviewees specialised in reprocessing of the salvaged materials into different products that are sold in the market. They equally believed economic hardship stimulated the emergence of their trade; additionally, they explained how it is more profitable to produce their wares with raw materials from the salvaged materials than with new raw materials (ENIE07).

Some other participants simply described the practice as natural. *"Natural! It is simply natural. When you remove something and somebody needs to reuse it, he will come to buy it or demand for it. It evolves naturally, simple! When there is supply and demand- that is it. If you remove something that someone wants use it, he will come to buy it or give him free"* said (ENIE06). In the same line of thought, (ENIE09) described the practice as a resemblance of nature as follows- *"It evolves from the constraint of wants and the constraint of materials. Let me give you an example, it is just like a hyena (in the wild), a hyena waits patiently to get somebody [sic] [*another predator animal*] finishes an animal and eat it and leave the scanty ones for her to eat. So that is how it happens. What you feel may not be useful to you maybe useful to those below you. That is how it works. When, may be the Government institution have to demolish a building, they think what can you do with this- it cannot go back into another construction, door frames we need new ones and so on. Those at the lower level will say, o.k. if you do not need it, we need it. That is how it all started".*

What this participant was trying to explain is the relationships of organisms in the natural ecosystems food chains where there is zero waste. What may be considered as unwanted (waste) material for one organism is the food (raw material) for another organism (Odum, 1983).

It is this concept in the natural ecological system that inspired the concept of industrial ecology as discussed in section 3.7.

Revisiting the economic hardship of Nigerians with Kano inclusive, the country is ranked as the 158th on the human development index; and as described by Aiyedogbon and Ohwofasa (2012), there is a tendency for the unemployed youth to engage in tedious occupations for lengthy periods with small earnings. It was reported that, while there are 4.5 million new entrants to the labour market per annum, only sixty per cent of the youth aged 15 to 29 are employed, and only 10 per cent of the new entrants find job (World Bank, 2011). It is therefore not a surprise if some of the participants associate the emergence of the phenomenon of this study with the level of unemployment. Nevertheless, as discussed in section 4.2, this study is not on political economy, rather based purely from the perspective of the sustainability agenda. It is therefore considered a good development that this industry provided a resort for the youth to be self-employed as well as protect the environment.

5.7.1.1 Urbanisation

The rural urban migration increases the urban population and stretches the housing supply in the cities. As a coping strategy to the undesirable situation of housing, people resort to the utilisation of the salvaged materials to rebuild residential buildings for themselves. This is the opinion of one of the interviewees (ENIE14); who said, it is caused by the population and increase in demand for more places - residential, commercial, etc.

Another interviewee believes that urbanisation plays a role but in a different way. He tried to explain how the rapid and uncontrolled developments in the urban centres necessitate urban renewal projects by the Government to create roads, drainages and other infrastructure. In the process of imposing the infrastructure on already developed settlements, demolition becomes inevitable. And, when buildings are demolished, materials are salvaged for reuse (ENIE04).

5.7.2 Culture and Belief

Five of the sixteen interviewees representing 31% of the total mentioned culture and belief among other factors that influence the prevalence of the reuse of salvaged building materials in Nigerian society (ENIE03; ENIE07; ENIE13; ENIE14; ENIE16). A participant remarked, *“this depends upon the culture and level of development of any community. Here in Kano in Kurmi market you see a shop built in 1904 alongside another shop that was decommissioned and rebuilt probably this year…*” (ENIE13). It may be speculated that these participants might be referring to the old tradition and customs of the Hausas described by Schwerdtfeger (1982, pp. 58,87-88). According to this aged tradition, a dead person is buried in or around his/her room and the buildings is allowed to collapse naturally over time. The timbers from the roof is used for a new building or as firewood, while the next generation reuse the mud and the space from the collapsed structure in making bricks and rebuilding another room. Possibly this culture along with other factors, may have unconscientiously influenced the prevalence of the culture of reusing of building materials among the present day Hausa community of Kano. Moreover, the Hausas are renowned for their conservative attitudes in so many respects (Adamu, 2006; Callaway, 1987; Whitsitt, 2003). In a study, West Africa, with Hausas was classified along short term orientation societies associated with the attribute of respect for traditions (Geert & Jan, 1991), a reason that may prompt them to maintain the old traditions.

Another aspect of the Hausa culture relevant to this discussion is the informal traditional housing and finance that provide the majority of the housing stock for the Hausas and probably Africa in general. The Hausas live in patrilocal communities organised in co-residential kinship groups whereby family heads are expected to self-build and provide residential accommodation for their families sometimes with some contributions from members of the kinship (Schwerdtfeger, 1982, pp. 33-35). This culture is further reinforced by the collapse of the official housing policy (Ogunshakin & Olayiwola, 1992), and myriads of other challenges facing the housing sector in Nigeria (Akeju, 2007). Where a family head may not be able to meet the financial demands, a resort to the salvaged materials might provide solution.

In the context of demolition waste management, this culture and tradition encourages the prevalence of reuse of salvaged building materials in yet another building or for other purposes not necessarily in the construction sector. In an analogy to the natural ecological systems, a waste from one building becomes a raw material for use in another building or other sectors eliminating any waste. This is practically a form of an industrial ecology. Moreover, reuse of materials is considered second most sustainable waste management strategy in line with the principle of the waste hierarchy and the EU directive on waste management (DOE, 2012b; Kibert, 2005; Nowak et al., 2009).

5.7.3 Belief

Belief on the other hand is another aspect that contributes to the prevalence of the practice. There is the tendency of the Hausas towards *argumentum ad antiquitatem* - ie appeal to antiquity. The Hausas believed that the older a material, the better its' quality. This philosophy may be a fallacy; nevertheless, it reinforces the culture of reusing salvaged building materials as well as attracting economic values to the materials. According to one of the interviewees with thirty (30) years of experience as an architect and a civil servant, he said: *"the older the material is, the more probability that, it will be of higher quality. You will realise that the most recent materials are even destroyed in the process of decommissioning; therefore they are less valuable"* (ENIE13) . He went further to elaborate on this point as follows:

"That is what I said- if what the stakeholder wants is aesthetics, then definitely newer materials from decommissioning may be valuable, but where quality is considered, the older ones are better. It is logical that if a building material can last for fifty years in a building and is still in good condition, it means the quality is tested and trusted. There is a probability that it will last for more years. Even the manufacturer of that components will enjoy preference for even the new materials he is making now; his products have been tested and even among the newer products now, his own will be more valuable. He has established goodwill with the public- his product has been tested and trusted". He was not the only participant with this view; (ENIE14) too expressed the same view.

The reasons for the prevalence of this philosophy may be beyond the scope of this write-up; however, this philosophy is friendly to the environmental sustainability thinking. It is contrary to the unsustainable fashion and trend psychology in other societies, whereby a seasonal cyclical phenomena is adopted temporarily and discarded as fast as it comes (Bhardwaj & Fairhurst, 2010).

5.7.4 Activities of the Government

A section of the participants opined that there is a co-relationship between activities of the demolition stakeholders and increase in Government demolition activities mostly due to upgrades of public buildings (ENIE02), removal of non-compliant structures (ENIE07), and provision of infrastructure (ENIE13; ENIE14). Demolition activities by the Government generates opportunities for different stakeholders in the salvaged materials trade; it is an industry driven only by the volume of the demolition projects.

According to another set of participants, the practice emerged as a public response to the building demolition activities of the Government. A correlation between the frequency of public buildings upgraded, and sometimes involving complete decommissioning of structures by the Government and the activities of the salvaged products market was implied (ENIE02; ENIE10; ENIE16). According to this line of thought, when the Government disposes buildings or part of the buildings, people realised that the unwanted materials can be useful in their personal property development.

5.7.4.1 Regulatory Functions of the Government

None of the participants indicated a function for the building approval authorities in practice. An insider from the regulatory authority identified only one circumstance where demolition may become relevant in the building approval process. It is usually when the staff of the authority realise that there is an undisclosed existing structure on the proposed site for new construction; the old structure should be demolished before the approval for a new development is given. He admitted that the practice of obtaining approval prior to demolition is rarely practiced. He said: *"there is a provision in the law to obtain approval before demolition a building but it is not practiced. The Federal Inland Revenue on Sani Marshal Road, former Club Road, submitted application for building approval, and they requested permission to demolish the old structure; and permission was granted; but this example is very rare; in my life for two decades, this is the only case I am aware" (ENIE16)*. Supporting the same position, another participant said, *"It does not really affect building demolition. Only in recent times and in some states that approval is emphasized. I think less than forty per cent of all buildings in Nigeria are approved"* (ENIE03). None of the participants disagreed with this position, rather it was suggested by others that the regulatory authorities should play a central role in the demolition of buildings (ENIE02; ENIE04).

5.7.5 Foreign Influence

There was an assumption that the current practice of building decommissioning in Kano was inherited from the British colonial practices. However, only one participant (ENIE12) had this feeling and could not support it with any evidence. Moreover, information obtained from some other participants contradicts this claim. A participant (ENIE01), cited occasions were up to date foreign companies operating in Nigeria especially British companies may give out the salvaged materials free of charge. Additionally, the volume of the construction and demolition waste generated currently in the UK and US, as two major foreign influences on Nigeria, and the inclination towards recycling over reuse out rightly contradicts this claim.

5.7.6 Professionals' Advice

According to the account of six participants, professionals play a significant role on how buildings are handled at the end of their life; one such incidence provided, the project manager and architect in charge narrated how he (along with his team) were mandated by the client to advise on the best method to demolish the building, how to dispose of the salvaged materials, and if some of the salvaged materials could be utilised in the new structure (ENIE11). On another occasion, in a university, a committee and the management only acted based on the advice of professionals, sometimes including the decision to demolish or not (ENIE08; ENIE12). According to some of the interviewees (ENIE04; ENIE05; ENIE07), it is the engineers or architects that provide the guidance on the procedures for the demolition of the structures.

5.8 Challenges Facing the Practice of End-of-life Management of Buildings in Kano.

There are challenges that need to be overcome in the practice of the end-of-life management of buildings in Nigeria starting from the use of outdated technology, payments, to fraud and payment of compensations by the Government; other challenges include occupational health and safety, public reactions, regulations, security, storage, and supervision as stated by the participants. These will be discussed below.

5.8.1 Technology

The use of manual labour in the demolition of buildings in Nigeria may not be by choice, as two of the interviewees believe it is the last resort where there is no equipment or is not affordable. *"Number one challenge is lack of equipment; the equipment are so scarce; where it is available, the cost of rental is very expensive; that is what we are going through in Kano; to the extent that you resolved to the use of human-power (manual labour) to carry out the works"* (ENIE15). There seems to be a desire for improved technology in the demolition practice as well as elsewhere in the construction industry (ENIE16).

On the other hand, while providing relief to workers, the use of machineries for demolition of buildings is likely to be associated with pollution and consumption of fossil fuel which are detrimental to the sustainability paradigm. On the other hand, the need for the materials to be removed in a usable condition may justify the use of hand tools rather than heavy machineries. There was a reported incidence whereby the available machines were abandoned for hand tools to minimise damage to the materials (ENIE13).

5.8.2 Illegality

There were reported cases of illegalities in the handling of salvaged materials after demolition, more especially in public projects. One of the participants narrated a story of diversion of the salvaged materials as *"The revenue from the sales of the salvaged materials usually do not come to the Government. The workers make private arrangements with the interested buyers. The contractors or the drivers of the trucks that are* *supposed to take away the rubbles to the landfill are approached by the interested parties with an offer to pay for the product to be diverted to their site. The workers and contractors take advantage of the opportunity. There is an owner known to me who is interested in reclaiming a pond for development; he is always on alert and ready to pay for such an arrangement"* (ENIE02).

Similarly, on another project involving a police barrack being converted into a general hospital there was a report of more daring encounter. The decommissioning project was taken over by the members of the public in a free-for-all scramble for the salvaged materials (ENIE13). This story is an indication for the need to develop a framework for the effective management of the process for the transfer of the salvaged materials; more especially as it may generate other problems like clashes with the security agents.

5.8.3 Harassment by the Law Enforcement Agents

The salvaged products marketers complained of harassment by the police on suspicion of the savaged products might be obtained illegally (ENIE07). As discussed above, the salvaged products industry is sometimes disreputable for the activities of the illegal actors in one way or the other.

5.8.4 Occupational Health and Safety

In two cases, occupational health and safety (OHS) issues were mentioned as part of the challenges in the building demolition sector which was discussed in details in section 5.6.

5.8.5 Public Reaction

The social environment as described by an interviewee (ENIE12) can be a challenge whenever public building is demolished; *"you face challenges from the surrounding people"* he said. This might involve pilferage and commotions associated with the competition to possess salvaged materials from the decommissioned structure. Another interviewee explained that when buildings are demolished by Government, it brings changes; and people are naturally averse to changes more especially if personal belongings like properties are involved (ENIE02). It was recommended that when public buildings are decommissioned, more especially where there is a change of purpose, understanding with the local community becomes a necessity (ENIE13).

5.8.6 Storage

There was a reported case whereby the rubbles from a decommissioned building were required for reuse in the would-be new structure; nevertheless, due to lack of adequate space for storage led to complaints from the site neighbours, therefore the rubbles had to be discarded and repurchased at a later stage of the project (ENIE11). Such circumstances were described as challenges by an interviewee, who said *"…you know, you need a store for other items too"* (ENIE11).

5.8.7 Supervision

The process of building demolition, more especially where the items may be needed for reuse, was described as hectic that requires a skilled and dedicated supervision (ENIE11). This was considered as yet another challenge for the industry.

5.8.8 Regulation

The business of demolition of buildings was considered as free-for-all and unregulated industry that requires rather a quick response. This may be in the form of regulations to guide the activity of the experts involved (ENIE04), or on how to manage the bye-products of the demolition projects (ENIE15). The different ways to improve the activities of the industry will be discussed in the following section.

5.8.9 Treatment of Hazardous Materials.

Most of the interviewees (80%) reported at least one hazardous material associated with demolition of buildings, nevertheless, only few (25%) suggested that there may be some precautionary measures taken when demolishing buildings. Materials recognised to be hazardous are asbestos (ENIE06; ENIE09; ENIE14), soakaway and septic tanks (ENIE04; ENIE10), dusts (ENIE02; ENIE03), iron rod reinforcement (ENIE05), and plastics (ENIE06). Others mentioned are broken glasses (ENIE08), exposed nails on timber (ENIE11), and chemicals (ENIE15). Unfortunately, it seems the workers may not always care about any precautionary measure when handling these items as suggested by a participant, *"To be very honest with you, those local people do not care about hazardous materials"* (ENIE14). On the other hand, there may be scanty use of facial masks, safety helmet and boots (ENIE02; ENIE16).

5.9 Improving the Practice of End-of-life Management of Buildings in Kano.

According to the research participants, there are eight (8) different ways that the practice of the end-of-life management of buildings in Kano can be improved as follows:

5.9.1 Standardisation

A number of the interviewees accepted that standardisation can bring improvement on how the salvaged materials from decommissioned buildings can be utilised. Nevertheless, informal standardisation methods have been part of the on-going practice of handling salvaged materials from decommissioned buildings. In the words of one of the marketers of the salvaged materials, *"Materials are graded informally for the purpose of marketing and maximising profit. Naturally, materials are not sold at the same price; the condition and level of deterioration of the item* *determines the price. The buyers too are aware and they buy according to their budget and the purpose it is going to be used"* (ENIE01). This claim was confirmed by another interviewee when he said, *"Yes, people categorize the materials according to their quality; even the prices are not the same"* (ENIE10). The two doctrines of *caveat emptor*- "buyers beware" and *caveat venditor*- "let the seller beware" are all operational in this circumstance. The seller grades the merchandise and prices it according to the quality and the buyer too inspects and purchases according to the suitability of the materials to his/her purpose. What may be absent from this process are the technical specifications such as materials strength, fire ratings and other materials properties specifications that might be specified in figures.

However, some other interviewees suggested that the *ab initio* properties of the materials come into play in this situation. ENIE06 for instance, remarked that, "*the initial grading of the materials helps in using as reusable material in a demolished building. You find that in some the deterioration over time is not significant [sic]"*. How much a particular item has deteriorated over time; and what its' capability to perform the same or different function in a building, and for how long? All these are questions that need to be answered!

Some of the interviewees think that some form of standards, guides, and legislations are necessary to minimise risks and develop a more organised sector (ENIE03; ENIE13; ENIE15; ENIE16). In order to emphasize this point, (ENIE12) stated that *"There is a need for standardisation; that is why I said there is a need for a comprehensive act of legislation; when we have the comprehensive act we have the standardisation, the description of the materials, the manual, the shop drawing of whatever we have. Whenever there is any building construction you have to furnish the client with all the information on how the building was erected including the lifespan and maintenance, and the method of erecting and coupling that* *building"*. This suggests a need for re-grading the materials before it is reused.

On the other hand, there are research and industry initiatives for reusing salvaged materials such as aggregates in construction in a number of countries (Brito & Saikia, 2013; Ledesma, Jiménez, Ayuso, Fernández, & de Brito, 2015; Rao et al., 2007). The Nigerian building demolition sector may be enriched from the experiences of other nations.

5.9.2 Material Database

The idea of developing and maintaining a materials database was accepted positively by all of the interviewees except two that expressed some scepticism about its' feasibility in the Nigerian context. Many do not think of this concept as new to the construction industry except for motivation; for example the Nigerian Institute of Architects (NIA) has been considering developing a material database to provide a quality authentication and reliable suppliers databank (ENIE14). An interviewee claimed to have attended professional meetings to promote the production of operation manuals including materials database for buildings at the completion of every building project (ENIE02). Another interviewee believed that the materials database and materials lifespan should just be part of the as-built documentation provided by consultants at the completion of a project (ENIE13).

5.9.3 Improved Tools

Improvement of how buildings are managed at the end of service may require the employment of modern tools for the demolition task. This is because at present, buildings are mostly demolished through manual labour (ENIE01). It is also important if these tools can be made affordable by the Government (ENIE15).

While some of the participants believe that the use of modern tools may help in improving the practice, as stated in section 5.9.1, there is a need for caution; as the machines may usually be associated with environmental degradation and consumption of fossil fuel.

5.9.4 Sensitisation and Education

Increased awareness on best practice for handling buildings at the end of service is considered to be one of the ways for improvement in the methods of demolition. This should include both public awareness and specific awareness for the stakeholders that are directly involved with the demolition activities and handling of salvaged materials (ENIE02; ENIE12; ENIE16).

On the other hand, according to (ENIE04; ENIE15), incorporating knowledge of sustainable building decommissioning into the curriculums of teaching built environment disciplines in higher education can bring improvement into the practice.

5.9.5 Policies and Legislations

Thirty-eight per cent of the research participants believe that legislations and policies can be instrumental to bringing improvement to the practices of managing buildings at the end of its lifecycle. *“The Government should come up with a law or edict that will guide so that you don't just come demolish*” is the statement of one of the participants (ENIE04). While, *“Guidelines for demolishing and the way of disposing waste should be well articulated so that it will help people to be at a safer side when demolishing any building or project”* is the statement of another participant (ENIE08). Environmental Impact Assessment (EIA) should also be a prerequisite requirement for permission to demolish buildings (ENIE15). Legislative edicts, comprehensive guidelines, and EIA are the three policy oriented approach identified that can improve the practice of handling buildings at the end of its service.

5.9.6 Demolition Specialisation

A set of the participants thought there are none or not enough experts and specialised companies involved in buildings demolition (ENIE06; ENIE07; ENIE08; ENIE09; ENIE13; ENIE14). This view was expressed in the words of (ENIE13) as follows, *"The advent of a set of professionals who will have interest in going into this area, I think even the value of the salvaged materials will increase. Because, they will provide a systematic and careful way of removing these materials and make proposals for where such materials could be reused for lower grade of buildings"*.

These interviewees might be referring to specialist groups in the style of associations like the UK's National Federation of Demolition Contractors (NFDC) and the European Demolition Association (EDA) (National Federation of Demolition Contractors, 2015). Specialisation and professionalization are likely to bring improvement to the practice (ENIE11).

5.10 Conclusion and Link

This chapter presented an overview of the industry for the end-of-life management of buildings from he perspective of actors in the industry and the sustainability principles. Starting from the description of how the research participants were selected to the conduct of the interviews and the analysis procedures.

The findings from the responses of the research participants were discussed under the subjects of the sustainable practices, occupational health and safety, the stimulant factors, and the challenges and ways of improvements. However, the most desirous finding was the confirmation of the postulation that there is virtually zero demolition waste in the society that is the subject of this study. This is important considering the contribution of buildings in the depletion of the finite natural resources, while dumping the same scarce resources in the landfill at the end of its services as discussed in section 2.3. However, as described by Hawkes

(2011), this is more prevalent in the extravagant culture of the present day industrialised societies. Imagine, if every human being on earth is to use the same quantity of paper as an American; there should have been no single tree remaining on earth (McDonough & Braungart, 2009). In fact, mankind should have barrowed three times more trees to meet the demand! Disparity in energy consumption can be up to 280 times more (Goodland & Daly, 1996), while in general the per capita resource consumption in Europe is twentyfold more than the developing countries (see section 2.1.4).

On the other hand, this culture of extravagance is gradually being transferred to the developing countries. The developing countries are racing to "catch-up" with the industrialised nations, and the economic success of a country is measured in terms of the GDNP. Nonetheless, what is surely certain is that the earth is not designed by nature to accommodate such culture of consumerism for all. In fact, realities are forcing the industrialised societies to re-trace their steps towards sustainable practices as the most important human agenda of the twenty first century (RIBA, 2009b).

There efforts in the search for sustainable solutions, from the biomimetic concept of industrial ecology, to designing for deconstruction among others (Benyus, 1997). Similarly, in terms of resources management there are sustainable solutions for waste management to reclaim materials back to the economic cycle (section 2.5). In the context of the construction industry, the Nigerian case presents a unique scenario that calls for this study.

It is a situation whereby interplay of economic and socio-cultural factors produces virtually zero demolition wastes, which is the desire of the sustainability paradigm. While this chapter discusses the practice from the perspective of the actors and in line with the sustainability principles, the following chapter will be on development of a conceptual model of the existing practice.

Chapter 6 : Developement of a Conceptual Model of the End-of-life Management of Buildings in Nigeria.

"Not quite; as I told you, every piece of metal, if it were not to be used in another building, even the minute piece of window if metallic, were taken by the people and sold for recycling. May be the pieces of broken glasses, not sizeable ones, because even the sizeable ones are recycled (reuse); in public buildings, we have large windows, and even if broken, parts of it can be resized for reuse in smaller windows; actually there was no waste"(ENIE13).

6.1 Introduction

In the present world of finite natural resources with increased pressure due to the world's population explosion, and industrialisation efforts in the developing countries and consumerism of the wealthy countries, any system with the potential of providing solution to material waste cannot be overlooked. Moreover, the enormous impact of the built environment to the depletion of the natural resources and greenhouse emission multiplies the justification for developing a conceptual model that will assist in understanding the interplay of the different variables that create a balanced system which produces virtually zero waste in Nigeria. Moreover, the unique approach of advancing the concept of biomimicry to ethnomimicry where some practices from the non-industrial societies are considered as possible sources of inspirations for providing sustainable solutions makes the development of this model imperative. The process, as well as the biomorphic concept inspired by the structure of the shell of an African snail, was used in developing the model as will be illustrated. The different elements that correlate to stimulate and sustain the system will be illustrated. The step-by-step procedure of handling the salvaged materials in such a way that minimum materials go to the landfill will be conceptualized and illustrated; while a comparative discussion of the model with the philosophy of the waste hierarchy will be made, as well as discussion on the limitations of the model.

6.2 The need for the Model

While acknowledging that solid waste management is handled by what was described as organised “formal” sector in the economically advanced countries, what is referred to as the “informal” recycling sector was credited for largely being responsible for the solid waste in the developing countries of Africa, Asia, and Latin America. However, the two systems exist side-by-side in the central and eastern European countries (Velis et al., 2012). Players in the system identified as “informal” operate either as organised cooperatives or as individuals providing door-to-door collection services and sometimes picking items from open dumpsites, transfer stations and communal bins. These informal players sometimes pay taxes and can, and are sometimes registered by the authorities (Velis et al., 2012).

The definition of the term informal solid waste management sector from a 2006 study was - “*the informal solid waste sector refers to individuals or enterprises who are involved in recycling and waste management activities but are not sponsored, financed, recognised or allowed by the formal solid waste authorities, or who operate in violation of or in competition with formal authorities” (Velis et al., 2012).* Nevertheless, this definition of the informal sector was identified as distinct from “the black economy” as is used in some senses. Impliedly, this system is termed “informal” simply because it lacks recognition by the “formal” sector. As defined by the Oxford Dictionaries (2015), the word formal means- 1. *“Done in accordance with convention or etiquette”; and* 2 *“officially sanctioned or recognised”*.

Multiple authors accepted that, "*There is increasing consensus among all stakeholders and experts that the informal sector in general, and the IRS in particular, should not and, in fact, cannot be ignored while attempting to improve waste and resource management systems in developing countries".* Furthermore, these "informal" systems were credited with the capacity of providing employment for 0.5% of the population, and achieve a recycling rate of 20-30%; while being market driven and saving local authorities 20% of its budget on waste management (Velis et al., 2012). Nevertheless, as these systems do not operate according to a predetermined convention or etiquette (mostly that of the OECD countries), it is not officially sanctioned or recognised and therefore "informal". This is irrespective of the possible relative advantages of such systems in terms of sustainability parameters.

On the other hand, a mention was made of the inadequacies of these systems including child labour, health and safety, tax evasion, crime, political tussles, pollution, and *"incompatibility with the image of a modern city"*. These shortcomings can however be averted by incorporating these systems into rather sustainable waste management system in a process termed as "integration", "inclusion", "formalisation", or "legalisation (Velis et al., 2012). In line with this thought that organisations such as the International Solid Waste Association (ISWA) Task Force on Globalisation and Waste Management is working out guidelines to actualise such processes. One of such efforts is the development of an analytical framework for the integration of the IRS into waste management systems in developing countries (Velis et al., 2012). Following an overview of similar recommendations from twelve different literatures, varieties of previous successful and unsuccessful attempts were identified, and an international workshop was organised in June 2011 whereby seven different case studies across developing countries was analysed in details. Thereafter, all the different approaches to integration were categorised into four; vis-à-vis, interface with the solid waste management system, interface with the materials and value chain, social aspects and the interface with the society, organisation and empowerment (Velis et al., 2012). A rapid evaluation and visualisation tool name InteRa was developed, which according to its architects was "*a concise and implementable methodological tool to evaluate broadly the relative focus (importance) of each integration/formalisation intervention case study…"* (Velis et al., 2012, p. 56).

In another effort authored by the United Nations Environment Programme (2013), pursuant to the recommendations of the United Nations Conference on Sustainable Development of June 2012 (Rio+20), a guideline for national waste management strategies for developing countries was proposed. The primary purposes of the guideline were targeted at the developing countries where the existing waste management approach is considered haphazard, disorganised, and under-resourced. Among the aim of the guide is to ensure that *"markets for recovered materials operate effectively"* and among the fundamental guiding principles is the waste hierarchy, the idea of product lifecycle, and waste as a resource.

A recap of all such moves, from the non-governmental organisations (NGOs) such as the International Solid Waste Association (ISWA) conference, to academic exercise such as the InteRa (discussed above), and outcome of world summit such as the Rio+20, the consistent and dominant theme is that, the systems of solid waste management in the developing countries is "informal", inferior, and less effective that should be integrated into what is referred to as "formal" and superior practices of the developed countries. This is despite the systems of the developing countries being run by cooperatives, providing door-to-door services, being registrable and taxable. This line of thought is informed by the widely accepted mind-set of the benefits capitalist development may bring to the developing countries (Sen, 1989).

However, in the words of De Soto (2001), when books are closed and eyes are opened, dramatic discoveries can be made about the achievements of the real people in the developing countries. Though De Soto might be referring to what is tagged as the “informal” financial activities in such countries as described in his master piece- *The mystery of capital:..* (De Soto, 2000), the same observation can be extended to the solid waste management practices. He argued that, against the common imagination of the westerners, in economic terms, these 80% of the world’s population are not as impoverished as it is imagined; in fact, the value of their savings is severally greater than the combined foreign aids and investments.

Likewise, in terms of environmental sustainability thinking in general and the solid waste management in particular, the benefits of the practices in the so-called “informal” sectors may be several times greater than imagined. The problem as described by De Soto (2001), is that the values in such systems are not documented or *“paperized”*. In the sustainability literature and solid waste management movements, the situation might be slightly different; such systems might be well documented in literature as discussed in Velis et al. (2012), however, it is always portrayed as inferior and “informal” systems that require integration and improvements to catch-up with the “formal” systems of the western economically advanced countries. Truly, such systems may have shortcomings; similarly, shortcomings are inherent in all other systems too! This thesis sought a paradigm shift, whereby such otherwise “informal” systems are considered as independent and “alternative” systems with huge environmental benefits and potentials for improvement and learning from the wisdom in the principles of its operations.

On the other hand, the United Nations Environment Programme (2013) recognised the merits of the informal sectors in its statement- *“The informal sector, which plays a vital role in many developing economies,* *can be recognised, protected, professionalised ..."* (United Nations Environment Programme, 2013).

Accordingly, the informal practices of the end-of-life management of buildings in Nigeria prove to be compliant with the sustainability agenda in many respects. It is a good practice case study of the waste hierarchy that evolves naturally with minimum policy and regulatory intervention. This practice was never planned, and there is no any direct legislation; there is minimum awareness about the sustainability as an emerging concept among the practitioners. In fact, the percentage literacy among the active players in the buildings' end-of-life management is probably among the lowest in the society. This practice emerges naturally as one of the industry players remarked: *"Natural! It is simply natural*"(ENIE06). Looking beyond the surface of this phenomenon shows that it evolved from the interplay of economic and social factors. Therefore, a conceptual model will be developed to present the key factors and their interrelationship (Miles & Huberman, 1994).

According to Koskela & Kagioglou (2007), a conceptual model is *"a type of diagram which shows of a set of relationships between factors that are believed to impact or lead to a target condition"*. A conceptual model usually illustrates the interrelationship between the constituent variables (Covin & Slevin, 1991).

6.3 Development of the Model

The development of a conceptual model for the end-of-life management of buildings in Nigeria in this chapter is in three stages, the process model and the contents model.

i. Stage I- establishes the factors that led to the emergence of the practice of the end-of-life management of buildings in Nigeria within the study context.
ii. Stage II- sets out the interrelationships of the factors to generate sustainable outcomes.
iii. Stage III- The operational output of the system

6.4 Stage I- Establishing the Variables that Contribute to the Thriving of the Practice

Guided by its definition (cited above), the first step for the development of a conceptual model is to identify the constituent variables and thereafter establish the interrelationship between the variables. The different aspects of the end-of-life management of buildings in Nigeria were presented in chapter 5. The variables can be classified into beneficial and harmful variables. In the context of this study, the beneficial variables are defined as factors that contribute to the thriving of the practice that are compliant with the principles of sustainability, while the harmful variables are factors that may also be contributing to the thriving of the phenomenon, however are not compliant with the sustainability principles.

The beneficial factors can further be grouped into four: the process of building decommissioning, economic factors, belief and cultural factors, and stakeholder roles. The good practices in the process of building decommissioning are materials sorting and handling; while the good practices related to economy are project finance, profitability, and political and national economy. The beliefs and cultural factors cover the culture of avoiding wastes, prolonged lifespan, repetitive reuse, beliefs, and customs. The role of the stakeholders as a variable covers professional advice, Government activities, and the role of the specialist stakeholders. The harmful factors on the other hand are grouped into two, the occupational health and safety, and lack of an improved organisation of the industry.

The typical “argumentum ad antiquitatem” philosophy among the Hausas and the aged tradition of recycling and reusing building materials from generation to generation are the two aspects of the culture that may have direct impact on the phenomenon under study. As discussed in section 5.8.2-3 and corroborated by the research participants, the Hausa believe that the older a material the more qualitative it should be. The reasons for the prevalence of this philosophy may be beyond the scope of this write-up; however, this philosophy is friendly to the sustainability and environmental context. This is contrary to the fashion and trend culture in other societies, whereby a temporary seasonal cyclical phenomena is adopted temporarily and discarded as fast as it comes (Bhardwaj & Fairhurst, 2010). A popular and well-accepted proverb among the Hausas says: *“da tsohuwar zuma ake magani”*, meaning, *“only an old honey can cure”*. This philosophy may be a fallacy; nevertheless, it reinforces the culture of reusing salvaged building materials as well as attracting economic values to the materials.

The aged tradition of the Hausas whereby the building materials used by the previous generations are recycled and reused by the subsequent generations is yet another aspect that was similarly discussed in section 5.8.2-3. The late Professor Schwerdtfeger (1982) discussed this phenomenon in more details in his book, *“Traditional Housing in African Cities:”*. These two cultural influences are considered to be part of the important drivers for the sustainable practice of end-of-life management of buildings.

Additional influencing factor is the national economy intertwined with the socio-political economy of the Nigerian society. As discussed in section 5.8.1, many of the interviewees believe that there is a correlation between the performance of the national economy and the culture of reusing building materials. When the national economy deteriorates, the purchasing power of the citizens worsens. This leads to the choice of salvaged building products rather than new ones for its relatively lower costs.

Moreover, the transition of the Nigerian consumer market from the British products and standards to the Chinese sub-standard products might further reinforce the culture of reusing building material (Falola & Achberger, 2013, p. 219; Raine, 2013). As an indication of the public sentiment, in the conventional and social media it was sometimes depicted that Nigerians consider “made in China” products to be synonymous with “poor quality”; and this psychology and experience of the Nigerian consumers was the subject of discussions in the Nigerian newspapers (Agency Report, 2015; Okafor, 2015).

The political economy of the Nigerian society is another aspect of the national economy that might have impacted on the culture of reusing building materials. The society is polarised between the super-rich elites and the poor with the absence of middle class. The statistics of unemployment and the controversies in the methodology of arriving at such figures suggested that the economic problems in Nigeria are less related to unemployment. What is most critical is rather income inequality between the geopolitical regions and the different social classes' representative of the society. The UK department for International Development Nigeria Stability and Reconciliation Programme was cited ascribing inequality and economic alienation as a motivating factor for deviant activities rather than unemployment (The Economist, 2014). To a lesser degree, such inequality may be argued to possibly drive the reuse of salvaged building materials culture. The lower social class stricken by poverty, absence of social housing, non-existent mortgage facilities are susceptible to adopt any available option for self-provision of shelter, which may include the use of salvaged building materials.

Another driving factor for the popularity of this phenomenon is the absence of any restrictive regulation or legislation; and where it may exist, it is not implemented. As discussed in section 5.8.4, the minimum impact of building regulations, and absence of any legislation, lack of consideration for standards, and indifference to occupational health and safety, may interact to create the favourable environment for the practice to flourish. Nevertheless, as discussed in section 5.10, the building regulations can be tailored to encourage the practice while at the same time inculcating the tradition of standardisation and occupational health and safety conscientiousness. This will be feasible when the stakeholders are enlightened that their physiological need for safety may not necessarily be in conflict with the pursuit of their economic targets. Furthermore, the natural human predisposition towards vitality, integration, and health will propel such an attempt at encouraging safety procedures on the Nigerian building demolition sites (Deci & Ryan, 2000).

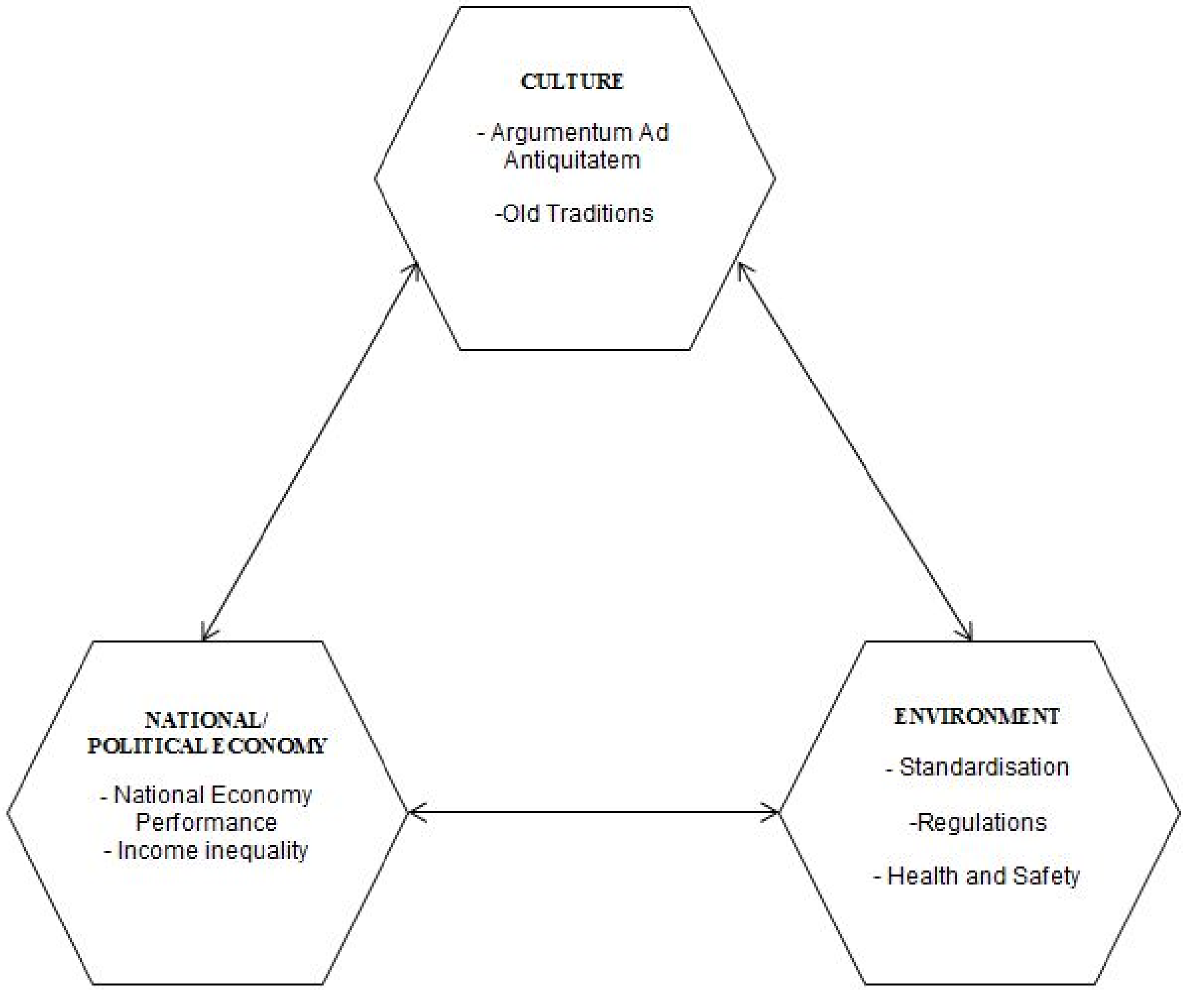


Figure 35: Conditions for emergence of the Nigerian practice of end-of-life management of buildings.

6.5 Stage II: The Interrelationship of the Factors

It was argued that, while waste management systems in the economically advanced nations are driven by legislations, economic incentives are the major force influencing waste management practices in the less economically advanced nations (Schneider & Ragossnig, 2014). Nonetheless, the motivation for the waste legislations in the economically advanced countries can equally be linked to economic reason, even though it is believed to be for sustainability purposes. This is because sustainability as a concept has its roots in economics; more especially if the linguistic origin and definition of economy as "the careful management of available resources" comes into play (Oxford Dictionaries, 2016). As mentioned in section 2.1, the definition of the term sustainability in the modern sense was adopted from the economics definition as defined by Sir John Hicks in 1946 (Goodland & Daly, 1996). Moreover, as discussed in section 2.3, the concept of economic sustainability was an economic concept first formulated by Thomas Malthus (Tahvonen, 2000). The waste legislations in the developed countries are in turn motivated by the sustainability principles. It can therefore be concluded that waste management practices in both the developed and developing countries are derived directly or indirectly by economic reasons.

The conditions that create the atmosphere for the existence of the economic incentives that guide a waste management system such as the phenomenon of this study without legislation were discussed in the previous section. How these factors interact and overlap to produce the desired outcome is explained in this section. This refers to the interplay of the both the beneficial and harmful factors to generate the economic incentive that sustains the industry of salvaged building materials in Nigeria. All the stakeholders and more especially the specialists *"Yangwangwan"* have one economic benefit or the other from the handling of the salvaged materials. To the end-users the economic incentive is in the low cost of purchasing the salvaged products compared to the alternative new building materials. While to the disposer the economic benefit is in the value of money gained from the sales of the salvaged products. Members of the supply chain take the advantage of serving as intermediary resellers that acquire the materials at a cost and sale at a profit to the would-be user. The workers and the "foragers" are equally attracted by the wages they earn and the potential for serving as reselling agents. The market and technology for upgrading the salvaged materials and conversion into some other products are other aspects of the phenomenon. The benefit to the Government is the jobs created for the citizens and the potentials for tax generation.

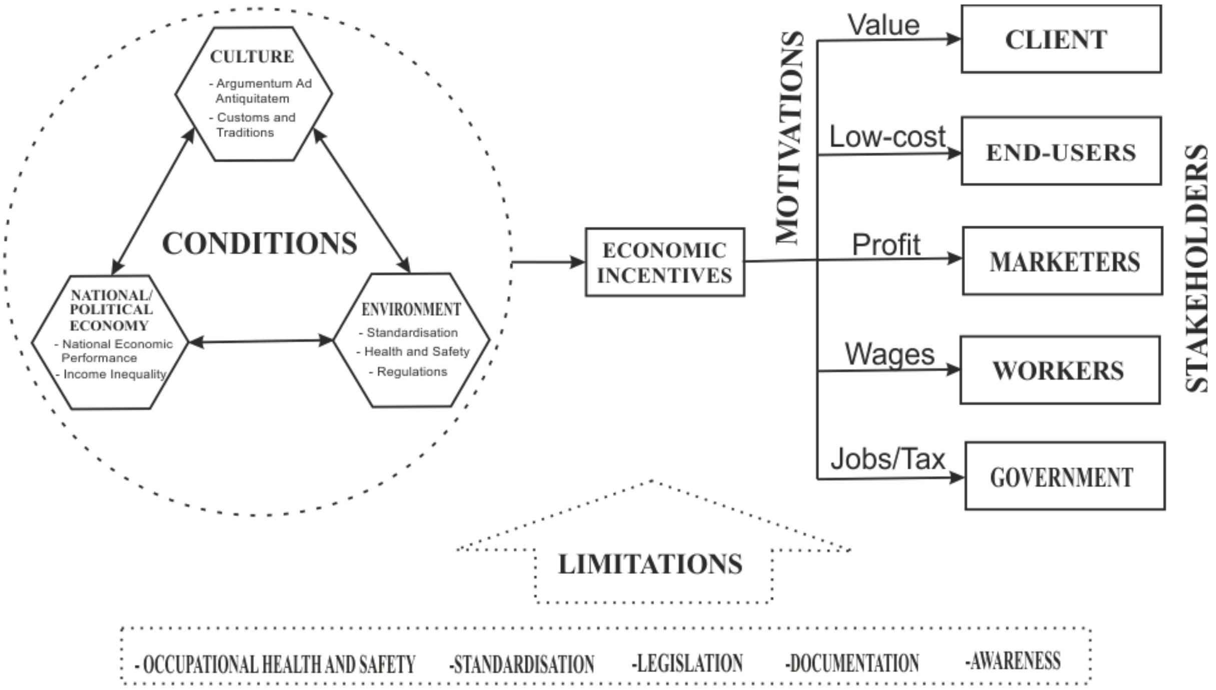


Figure 36: Operation mechanisms of the building demolition waste handling in Kano

Coincidently, the salvaged materials are handled in line with the principles of the EU waste hierarchy, however in a more unique style. As discussed in Chapter 2, the waste hierarchy recommends that the most sustainable and preferable manner of managing waste that cannot be avoided is reusing, followed by recycling, thereafter using the waste as fuel to recover energy; and unavoidably dumping in the landfill. According to the accounts of the research participants (Chapter 5), while the lifespan of the building is prolonged as much as possible to avoid generating wastes, all materials from a decommissioned building are salvaged for reuse in one way or the other; sometimes not necessarily in the same manner as in its original function.

The reuse of materials is in three different ways as in the concept of recycling, upcycling, and downcycling (Sassi, 2008). Where a material is reuse in similar role as in the decommissioned building can be referred to as simply reused or extension of its lifecycle; and where it is upgraded to be reused in a more significant role it can be referred to as *"up-used"*, and when used in a less significant role, it can be referred to as *"down-used"*. An example is the aluminium-roofing sheet that can be reused as roofing sheet, up-used as partition or as a door, or down-used to produce smaller products such as pots or a mould.

Deducing from the accounts of the research participants, a theoretical filter akin to the hard gate 1, adopted from the Process Protocol (Lee, 2002; a model developed in the UK that aimed to provide a generic process that encompasses best practice for the whole design and construction sector), can be assumed whereby all salvaged materials are screened to ensure that only materials that cannot be reused in any other way whatsoever are allowed to pass to the recycling phase. While only materials that could not be used are considered for recycling, there is another filter or hard gate 2, which sieves the material to ensure that only materials that could not be recycled pass to the next stage for energy recovery. Materials that could neither be reused nor recycled are considered for energy recovery. Where the material could not be used as fuel, then it may unavoidably be dumped in the landfill after undergoing another screening at hard gate 3. In this process, most of the salvaged materials were reused and smaller proportion of the materials were recycled, and much smaller proportion were treated as fuel, while very little quantity is deposited in the landfill. The concept of hard gate adopted from the Process Protocol refers to a resolute decision prior to proceeding to the next stage of a process (Aouad et al., 1998).

This was further attested by an analysis of the municipal solid waste conducted by Nabegu (2008c) and Nabegu (2010). In one of these studies samples of the municipal solid waste were collected for three months from landfills in three different residential areas of Kano according to Gordon guide for data collection in cities; and the samples were separated into groups for analysis. In the second study, secondary data was collected from the only Government agency responsible for the management of municipal solid waste, the Kano State Refuse Management and Sanitation Board (REMASAB). The different classifications of the solid wastes in these studies include biodegradable matter, industrial waste, non-biodegradable matter, including some glasses and metals. However, there was no mention of demolition and construction waste whatsoever. The small pieces of glasses and metals might likely be from household items such as bottles and cans and probably very insignificant quantity from building demolition as discussed in section 5.5.1.3. Demolition and construction by-products are not considered as waste in this community; it is rather a marketable commodity with a relatively developed market and stakeholders. Handling of the reusable building demolition by-products constitutes an independent economic sector with various players. How the materials are handled with minimum quantity going to the landfill can be demonstrated in a process diagram below.

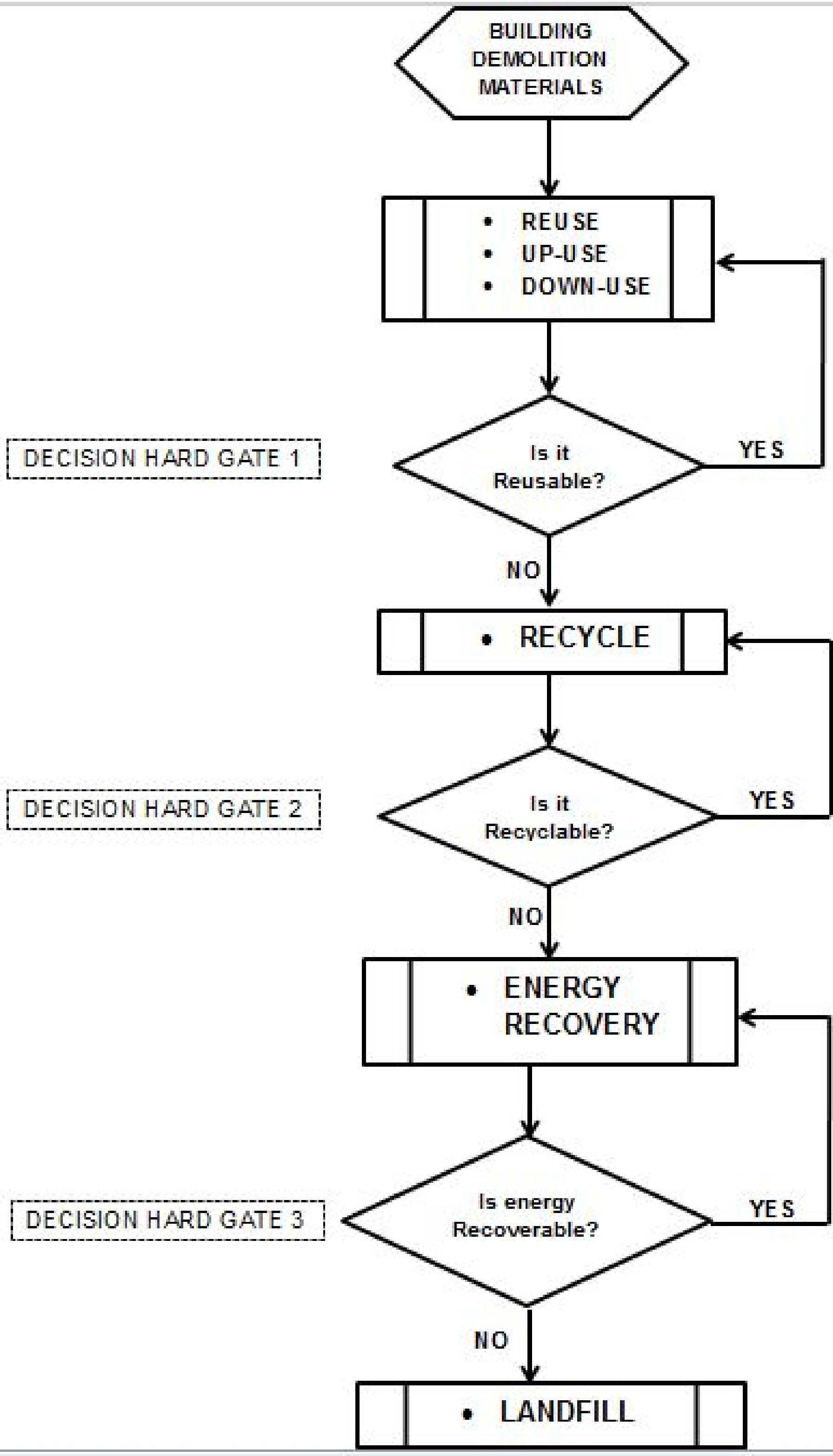


Figure 37: Salvaged Building Materials Handling Process in Kano Nigeria

6.6 A Concept for the Model

The above process can be represented as a conceptual model using the biomorphic structure of an African land snail. Biomimicry refers to the development of sustainable solutions to human problems by adopting biological principles from nature (see section 3.7), whereas biomorphism is the mimicking of naturally occurring physical forms without necessarily any similarities in functional principles (Pawlyn, 2011, p. 2). The physical structure of the shell of the giant African snail can be used to explain the elements and its interrelationships in the operations in the end-of-life management of buildings (Figure 38). The protective coiled shape of the snail shell is in segments, and each of the segments can be considered to represent a procedure in the overall process of salvaged materials handling.

While the head of the snail is visible above the shell when it is not retracted, a typical shell consists of segments that are disproportionate in size and arranged in a diminishing order to form a funnel shape structure. The first and largest segment is 50-60% of the overall size of the shell, followed by the second segment that is about 20% of the overall size. The third and fourth segments are within 8-15% range each. The fifth and sixth segments are much smaller of approximate proportion of 1-5% of the overall size of the shell. Each of these segments is twisted as a segment of a spiral that is connected to the next segment forming a complete bigger spiral (see figure 39 below).

Figure 38: African snail (http://www.fotolibra.com/gallery/41499/giant-african-land-snail-illustration/)

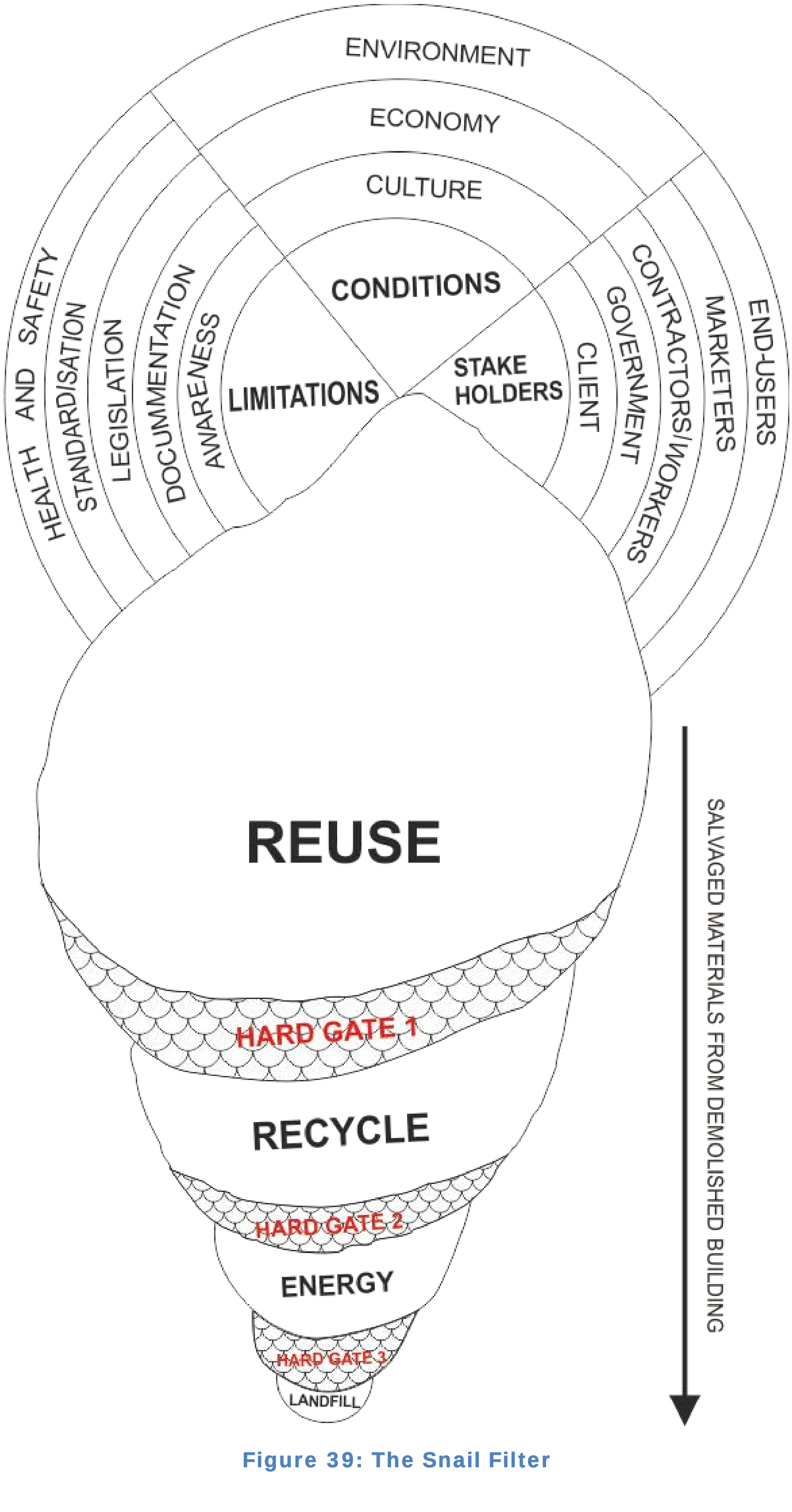


Figure 39: The Snail Filter

The segments of the structure of the African snail's shell can represent the process of materials handling at the end-of-service of buildings in Nigeria, which produces zero waste. The activity starts with the removal of materials while dismantling the building structure. The materials are removed in most cases with the reuse agenda as a sanctuary for the materials instead of dumping in the landfill; this is similar to the retraction of the snail head and body into the shell for protection on sight of danger. When the salvaged materials are retracted into the protection of the "shell", the first and bigger segment can be assumed to represent the reuse of the salvaged materials, which is the largest and most important technic used in materials handling and is represented in the first and largest segment of the snail shell. Most materials, probably as much as 50-60% representing the proportion of the first segment of the snail shell, are reused as narrated by the research participants. Materials that could not in any way be reused in exactly the same purpose or for a different purpose will be examined for viability for recycling; and this is done by passing through a conceptual filter or hard gate that guarantees only qualified materials pass to the next segment. The recycling procedure can be assumed to be represented by the second and third segments of the shell; and all materials that are recycled are recommended not to be in excess of 20% coinciding with the proportion of the corresponding shell segments. Other materials that do not satisfy any of the conditions in the previous stages can be considered for use as fuel after passing through another imaginary filter and are recommended not be more than 10% of the materials to coincide with the proportion of the fourth segment of the shell. Then the fifth segment coinciding with disposal in the landfill should not be more than 5% coinciding with the proportion of the fifth segment of the snail's shell. However, it should be noted that the numerical percentages are only recommendations inspired by the proportion of the segments in the snail shell, as this study does not involve quantitative measurements.

The upper part of the model corresponding with the head of the snail represents the variables that contribute to the thriving of the practice and the interrelationships of the variables as discussed in section 6.4 above.

6.7 Operational Output of the Model: The Snail Model and the Waste Hierarchy

Whereas the EU was engaged in legislations to achieve sustainable waste management including demolition waste, with arguably negligible progress, the operations of the salvaged materials industry in Nigeria is found to be compliant with the principles of the waste hierarchy. This naturally evolved practice is so effective that it produces virtually zero demolition waste as discussed in chapter 5. An examination of this practice suggests that the predominant strategy used by this “green people”, in the words of Turteltaub (1999), is reuse. As a condition, materials are only recycled if it cannot be reused. And only materials that can neither be reused nor recycled are used as fuel; thereafter, as a last option, it may be deposited in the landfill. Materials not suitable for reused for the same purpose in another construction project, may be reused in another sector including agriculture and household equipment, among others. This proves this practice to be an improvement over the predominantly recycling culture inspired by the waste hierarchy in the EU countries in terms of sustainability objectives. There are shortcomings associated with the practice; even though, the alternative practices equally have limitations.

Based on the accounts of the research participants, some quantitative dimensions can be speculated to understand further the workings of this model. Using the proportion of the constituent segments of the snail shell, an approximately 60% of all materials may be considered as being reused, while 20% is probably reused in other sectors. Recycling and energy recovery that are rarely employed can probably be close to 9% each; while materials disposed in the landfill may only be 2%. However, this is subject to further studies and verifications.

It is worthy to note that, the most sustainable waste management approach in the waste hierarchy- avoidance and reduction of waste are the most prevalent in this society (see section 5.5.4). Buildings lifespan are extended as long as possible. Buildings are designed and constructed for longest possible lifespan (albeit with any limitations of materials, labour skills and technology available). Such are the positive attitudinal changes that the waste hierarchy has not addressed. Furthermore, the waste hierarchy is limited for not providing recommendation for the amount of waste to be reused, recycled, or for generating energy as accomplished in the snail filter. Nonetheless, there are equally some limitations in the snail filter as will be discussed in the following section.

6.8 Limitations of the snail Filter Model/ Ethnomimicry of the Nigerian Model of the End-of-life Management of Buildings

The limitations to the snail filter model as discussed in chapter 5, include occupational health and safety, standardisation, legislation, documentation, and awareness. If these limitations can be addressed and incorporated into this model, a complete framework for the sustainable management of demolition waste can emerge. Awareness and legislations can be used to drive occupational health and safety, standardisation and documentation. Educating the stakeholders by curriculum development, public campaigns, trainings and workshops will provide an improvement in the practice; while legislations that are not implemented may not likely bring any significant improvement. As demonstrated by a survey conducted by Idoro (2008), Occupational Health and Safety can be improved through an effort by the management of the construction companies. However, it might require some initiatives from the Government, which may involve legislations and policy reforms that will motivate the construction companies. This approach may be extended to standardisation and documentation.

The observation of Idoro (2004), that many legislations in Nigeria related to building construction were adopted from the United States or from the UK (see sections 5.7 and 5.9.4); it is however contentious if such imported legislations can be as effective in the society with completely different cultural orientation. It will be an equivalent of speaking a foreign language to a native while expecting him/her to immediately grasp and use the language fluently! The same type of question was answered by Hofstede (1980), while discussing motivation and leadership in organisations and why American theories may not work elsewhere. Following a survey of the employees of a multinational organisation with samples whose only difference is in their nationalities, he concluded that many of the employees' motivation, organisational structures, and management styles are influenced by the national cultures. He defined culture as *"the collective programming of the mind which distinguishes members of one group or category of people from another*" (Geert & Jan, 1991). He went further to formulate four parameters (later updated to six) that can be used as criteria for defining differences between national cultures. These parameters referred to as cultural dimensions are *Power Distance, Uncertainty Avoidance, Collectivism or Individualism*, and *Masculinity*; others are *Long /Short Term orientation*, and *Indulgence/Restraint* (Hofstede, 2011). In different other works, the correlation of the Hofstede's cultural dimensions was demonstrated in management theories, employee motivation, leadership, organisational structure, planning and problem solving approaches (Hofstede, 1980, 1984). Nevertheless, it is intended here to implore the cultural dimensions to justify the need for a bespoke approach in addressing the limitations of the *Snail-filter.* Moreover, there is an established relationship between environmental sustainability and the national culture as hinted in the writing of Park, Russell, and Lee (2007).

Legislation might be used as a tool to improve the observance of Occupational Health and Safety in building demolition in a European country as an example; however, it may not be as effective even if the same legal instrument is transplanted in Nigeria. This is because according to the cultural dimensions' theory; the Nigerian society belongs to the culture of very weak uncertainty avoidance characterised by high tolerance of risks and aloof to written rules and regulations. Probably, the use of cultural symbols, heroes, and rituals may be more effective than legislation. The limitation of standardisation shares the same fate with Occupational Health and Safety. The observation of De Soto (2001), cited in section 6.2, that the reason capitalism may not work in developing countries is that economic possessions are not *"paperized"*- meaning documented. In such an environment where ownerships are not readily documented, then it will even be more challenging to document activities related to building demolition. Nonetheless, increased awareness about the implications and significance of incorporating standardisation, occupational health and safety coupled with the use of symbols, ritual, and heroes may perform where legislations may fail.

6.9 Conclusion and Link

In this chapter a conceptual model was developed representing the real life situation of demolition waste handling in Nigeria using the biomorphic adaptation of the shell of an African snail. However, in order to establish the reliability, sufficiency, clarity, simplicity, and usefulness of this model as discussed in section 4.10, two workshops and focus group discussions were conducted in order to validate the model. In the next chapter 7, is the outcome of the validation process.

Chapter 7 Validation: Does the Conceptual Model Describes the Practice of the End-of-life Management of Buildings in Kano, Nigeria?

"All field work done by a single field-worker invites the question, why should we believe it" (Bosk, 1979 in (Maxwell, 1992).

7.1 Introduction

The issue of credibility and validity in research is discussed in Section 4.10. In this research, being a qualitative inquiry, in addition to peer debriefing occasioned by the input of the academic advisor to the researcher, an external audit approach was used to validate the process, findings, and interpretations of the data used to develop a conceptual model of the end-of-life management of buildings in Nigeria. This is in the form of two focus group workshops organised in the local community of the study. The first workshop was organised in the academia and the attendance was dominated by academics from the built environment and related fields. The second workshop was organised in collaboration with the Kano State chapter of the Nigerian Institute of Architects and the attendance was made up of professionals from different backgrounds including some academics, and one of the original research participants.

7.2 Workshop One at the Kano state University of Science and Technology (KUST) Wudil, Kano-Nigeria.

The workshop was held on 31st December, 2015 at the Faculty of Earth and Environmental sciences of the Kano State University of Science and Technology, Wudil and was attended by faculty and students (See Appendix 8: Workshop 1 Attendence Register). The title of the presentation was *"Ethnomimicry of the Nigerian Model of the End-of-Life Management of Buildings*.

The presentation started with an overview of the development of unsustainable architecture and the need for sustainable architecture. The negative impacts of the Industrial Revolution such as natural resources exhaustion, environmental pollution, ecology and biodiversity damage, and waste generation was discussed. The realisation of mankind that the carrying capacity of the earth is limited and the need to use resources sustainably either by choice or forced by nature; and as a reason which led to the sustainability concepts was discussed. The unsustainable practices in construction were discussed, particularly in terms of energy consumption, emissions, and enormous natural resources exploitation. Thereafter, the unfortunate linear trend of dumping the materials in the landfill at the end of service of the buildings was highlighted with reference, more particularly, to the practices in the economically developed countries. It was however, pointed out how the practice of the end-of-life management of buildings in Nigeria and Kano in particular differed from the practices in the advanced countries.

The presentation described the merits of the Nigerian practices where there is virtually zero demolition waste. The argument that at such critical time in the history of technological and economic development of mankind, the search for solution may and should include systematic study of the models of the preindustrial societies. This was discussed as one of the motives for conducting this research, to understand who are the main players? What are the socio-economic conditions that make the practice to flourish? How are the day-to-day operations conducted? What are the shortcomings in the practice?

The method that was used to conduct these inquiries was described to the participants of the workshop. This includes selection of the participants, conducting the interviews, and analysis of the data and ethical related issues. The findings of the research were equally summarised and presented as the variables that support the practice to flourish. Then, the interaction of the stakeholders largely motivated by economic incentives produces the observed outcome naturally with minimum policy or legislative intervention. Another outcome of this inquiry is how materials are, as a matter of an unwritten rule, always designated for reuse until otherwise not suitable for reuse, and then it is recycled. And it is only when it cannot be recycled that it may be considered for generation of energy. As such, virtually zero bye-products from the demolition of buildings end in the landfill.

On the other side, there is utter disregard for occupational health and safety issues, and documentation; standardisation was also observed to be casual, while the operations are not guided by any legislation. It was also observed that there was lack of awareness among the stakeholders about what is good or bad practice in the system.

The audience was informed about how the researcher interpreted the interactions of the stakeholders and the operations of the system to produce zero waste to be analogous to the natural ecological systems where there is no waste. In the natural systems, the by-product from one process becomes the raw material for another process and materials are utilised in a closed loop. The Nigerian system of handling materials from building demolition resembles the natural ecological system in many respects. It was further clarified that an attempt to organise human industrial activities in the fashion of the natural ecological system is one of the biomimetic concepts that has become a discipline of its own known as *"Industrial Ecology"*. The diagrammatic representation of the operations of the system and that of the elements were presented to the audience.

The concept of biomimicry was briefly revisited as the basis for the use of biomorphic physical shape of an African snail to develop a conceptual model that describes the practice of end-of-life management of buildings in Nigeria. Furthermore, the proposal for the development of the Biomimicry concept into another concept of *"ethnomimicry"* was introduced to the participants.

Whilst the proceedings of the workshop were video recorded, as a closing remark, the participants were asked to comment on every aspect of the presentation and more especially if the conceptual model represents the real-life situation of the end-of-life management of buildings in Nigeria.

7.3 Feedback from Workshop One.

The research participants accepted the conceptual model as a representation of the real-life situation of the practices of handling buildings at the end-of-service in Nigeria, and did not propose any amendments. And a participant expressed astonishment with the term *"ethnomimicry"*. Some of the observations made by the workshop participants will be discussed below.

7.3.1 "Modernity is our Problem".

A commentator remarked that, *"modernity is our problem. Traditionally building materials are reused or recycled in mud construction"*. This is in consonant with the discussion in Chapter 5 about role of culture and tradition on the building practices. It is also in line with the writings of Hawkes (2011), that traditional architectures before the Industrial Revolution was predominantly sustainable.

7.3.2 Relevance of the Snail and the Biomimicry Concept.

A participant commented that though he understood the concepts and the message of the conceptual model, however, he was confused on to the relevance of a snail and its' picture into the whole scene.

The relevance of nature as a teacher for sustainable solutions was discussed in section 3.7, and the biomimicry concept of Industrial Ecology whereby human industrial activities are organized in the fashion of the natural ecological systems that produce zero waste. Natural systems are considered as the best models for waste management. Moreover, in this research it is discovered that the Nigerian practice of the end-of-life management of buildings resembles the natural system in many respects. It is therefore thought by the researcher that, as a signpost to signify the resemblance of the practice to nature, a biomorphic shape is chosen to illustrate the model, and it could be any other natural shape considered suitable.

7.3.3 Can the Society Avoid the Trend of the Economically Advanced Countries?

In an attempt to provide solutions to human problems such as the need for shelter, for how long can the society avoid going the unsustainable path of the economically advanced countries? This question was asked by three of the workshop participants in a slightly different mode.

This question raises the discussion in section 2.2 about the politics of sustainability and the tendency of the developing countries to be apprehensive about the sustainability agenda (NAJAM, 2005).

In response to these questions the presenter explained that the issue of sustainability is global in nature. Environmental problems such as the global warming, or ozone layer depletion knows no border. It is one and the same earth that we collectively occupy. On the other hand, the reuse of materials does not in many ways jeopardise the efforts of providing solutions to human challenges; in effect, it may even enhance such efforts. As discussed in Chapter 5, the salvaged building materials industry in Nigeria generates employments, as well as help towards providing affordable shelter. Moreover, sustainability is about satisfying human needs, nevertheless with the interest of the future generations in mind.

7.4 Workshop Two: The Nigerian Institute of Architects (NIA), Kano State Chapter.

The second workshop was organised in collaboration with the Nigerian Institute of Architects, Kano State chapter. However, the attendance included Engineers, Quantity surveyors, Town planners, and building Engineers. An invitation was sent to all other professionals via their respective professional bodies. The attendees included practitioners, public servants, students, and academics (see appendix 9: Workshop 2 attendance register). The workshop took place at the Kano State secretariat of the NIA (named M.T. Waziri House) on the 17th of January, 2016.

The presentation at the second workshop was similar to the first workshop, except the date, venue and time. Nevertheless, the feedback from the audience was slightly different as discussed below.

7.5 Feedback from the Second Workshop.

There was a consensus by the workshop participants that the conceptual model was a true representation of the real-life practice of the end-of-life management of buildings in Nigeria, and too, did not propose any amendments. Moreover, two commentators recommended that the study should be promoted to improve awareness about the ecological benefits of the local practices. One of the commentators, who is a public servant, suggested that there are possible areas of collaboration between the researchers and Governmental organisations more especially in advancing the local practices of demolition waste management. Other contributions and observations made by the workshop participants include the choice of conceptual model over a framework, the national environmental standards legislation, pollution from the activities of *"Yangwangwan*.

7.5.1 Conceptual Model versus Conceptual Framework.

A commentator recommended the development of a detailed prescriptive conceptual framework rather than a conceptual model that only describes the happenings in real life situation. Other participants too recommended the promotion of the outcome of the research and the merits of the Nigerian practice of the end-of-life management of buildings as well as to serve as an inspiration for the locals for the development of indigenous practices. This was a valid recommendation; nevertheless, the scope of this research is limited to the development of a descriptive conceptual model that will help in understanding of the practice of the end-of-life management of buildings in Nigeria. Development of a prescriptive conceptual framework is however, accepted by the researcher as part of the recommendations for future research.

7.5.2 The National Environmental Standards Legislations.

One other participant informed the workshop that the federal Government legislations on Environmental Impacts Assessment and the National Environmental standards include sections on waste and the end-of-service management of buildings. He recommended that the researcher should look-up the text of the two legislations while discussing the impacts of legislations on the phenomenon under study.

A review of the *"Environmental Impact Assessment Decree No 86 of 1992 Laws of the Federation of Nigeria"* shows that end-of-life management of buildings was not specifically treated in any format. However, as item 18 on the schedule of *Mandatory Study Activities* according to the decree was *Waste Disposal and Treatment* facilities under the three categories of *Toxic and Hazardous Waste, Municipal Solid Waste*, and *Municipal Sewage*. The decree went further to specify under each category the different types of facilities whose construction will require a mandatory study without any specific reference to construction or demolition waste (International Centre for Nigerian Law, 2016).

On the other hand, the National Environmental Standards and Regulations Enforcement Agency (NASREA) was established by an act of Nigerian parliament in 2007 with the general mandate of enforcing and coordinating environmental laws, policies, and guidelines including international environmental policies, which Nigeria is a signatory. According to the official website of the agency (National Environmental Standards and Regulations Enforcement Agency, 2016), there are 33 officially documented environmental regulations in Nigeria (see table 9); among which is the *National Environmental (****Construction Sector)*** *Regulations, 2010. S. I. No. 19.* This regulation according to Ladan (2012) was specifically targeted at the Construction Sector with the aim of minimising pollution from construction, decommissioning and demolition activities in Nigeria. Nevertheless, is pollution the priority problem of construction activities in Nigeria including decommissioning and demolition? This may be a question for another discourse; as the findings of this research suggests, the occupational health and safety, standardisation, and documentation are more of a concern in the practice of end-of-life management of buildings in Nigeria. Notably, in the sister regulation, *National Environmental (Sanitation and Wastes Control) Regulations, 2009,* there was no mention of the Construction and Demolition Waste. This may be considered as another testimony to the insignificance of the demolition by-product as wastes in Nigeria. As disclosed in another research by Nabegu (2010), whereby the different streams of solid wastes from landfills in Kano where analyzed, construction or demolition wastes were not identified.

S/N	Date	Legislation
1	2009	National Environmental (Wetlands, River Banks and Lake Shores) Regulations, 2009;
2	2009	National Environmental (Watershed, Mountainous, Hilly and Catchment Areas) Regulations, 2009;
3	2009	National Environmental (Sanitation and Wastes Control) Regulations, 2009;
4	2009	National Environmental (Permitting and Licenses System) Regulations, 2009;
5	2009	National Environmental (Access to Genetic Resources and Benefit Sharing) Regulations, 2009;
6	2009	National Environmental (Mining and Processing of Coal, Ores and Industrial Minerals) Regulations, 2009;
7	2009	National Environmental (Ozone Layer Protection) Regulations, 2009;
8	2009	National Environmental (Food, Beverages and Tobacco Sector) Regulations, 2009;
9	2009	National Environmental (Textile, Wearing Apparel, Leather and Footwear Industry) Regulations, 2009;
10	2009	National Environmental (Noise Standards and Control) Regulations, 2009;
11	2009	National Environmental (Chemicals, Pharmaceuticals, Soap and Detergent Manufacturing Industries) Regulations, 2009;
12	2011	National Environmental (Base Metals, Iron and Steel Manufacturing/Recycling Industries Sector) Regulations, 2011;
13	2011	National Environmental (Coastal and Marine Area Protection) Regulations, 2011;
14	2011	National Environmental (Construction Sector) Regulations, 2011;
15	2011	National Environmental (Control of Bush, Forest Fire and Open Burning) Regulations, 2011;
16	2011	National Environmental (Control of Vehicular Emissions from Petrol and Diesel Engines) Regulations, 2011;
17	2011	National Environmental (Desertification Control and Drought Mitigation) Regulations, 2011;
18	2011	National Environmental (Domestic and Industrial Plastic, Rubber and Foam Sector) Regulations, 2011;
19	2011	National Environmental (Electrical/Electronic) Regulations, 2011;

20	2011	National Environmental (Non-Metallic Minerals Manufacturing Industries Sector) Regulations, 2011;
21	2011	National Environmental (Protection of Endangered Species in International Trade) Regulations, 2011;
22	2011	National Environmental (Soil Erosion and Flood Control) Regulations, 2011;
23	2011	National Environmental (Surface and Ground Water Quality Control) Regulations, 2011;
24	2011	National Environmental (Standards for Telecommunications and Broadcast Facilities) Regulations, 2011;
25	2012	National Environmental (Quarries and Quarrying Operations) Regulations, 2012;
26	2012	National Environmental (Alien and Invasive Species) Regulations, 2012;
27	2012	National Environmental (Pulp and Paper, Wood and Wood Products) Regulations, 2012;
28	2012	National Environmental (Motor Vehicle and Miscellaneous Assembly) Regulations, 2012;
29	2013	National Environmental (Air Quality Control) Regulations, 2013;
30	2013	National Environmental (Control of Charcoal Production and Export) Regulations, 2013;
31	2013	National Environmental (Dams and Reservoirs) Regulations, 2013;
32	2013	National Environmental (Hazardous Chemicals and Pesticides) Regulations, 2013;
33	2013	National Environmental (Energy and Energy Efficiency) Regulations, 2013;

Table 9: Nigerian National Environmental Regulations (NASREA, 2016).

Nevertheless, from the responses of the research participants about legislations guiding the handling of buildings at the end-of-service, there was lack of awareness of any law or regulation by the stakeholders; which implies minimum impact of the legislation on the industry for discussions on legislations relevant to the end-of-life management of buildings in Nigeria. Additionally, the activities and existence of the industry, predates the regulation that was gazetted in 2011.

On the other hand, the *National Environmental (**Construction Sector)** Regulations, 2010. S. I. No. 19* emphasis was on pollution rather than waste as reported by Ladan (2012) and the *National Environmental (Sanitation and Wastes Control) Regulations, 2009 equally failed to address wastes from construction and demolition activities.* Legislation is therefore needed to address the challenges specific to waste generated from construction and demolition activities in Nigeria. Sensitive issues to be addressed include occupational health and safety and material standardization before reuse.

7.5.3 Some activities of the *"Yangwangwan* (Stakeholders) Produce Pollution.

"Yangwangwan is the term in the local Hausa language used to refer to all stakeholders whose primary business is in dealing with the salvaged building materials. The existence of a dedicated term itself signifies the entrenchment of the system among the locals. A participant informed the workshop how in an attempt to recover copper for recycling from electrical cables, the activities of some "yangwangwan involve burning and emission into the air. It should be noted that this is part of the process for recovering materials for recycling, which was acknowledged in the description of the conceptual model.

Recycling is usually associated with energy consumption and emission, a reason that makes it less sustainable than reuse as an option of waste management, among other reasons as discussed by Schneider and Ragossnig (2014). Moreover, this response further suggests that minimum materials (only copper) were reported to be recycled.

7.5.4 Future Legislations and the Activities of the "Yangwangwan.

The observation of one of the participants is that all future legislations should encourage rather than discourage the practice of the end-of-life management of buildings, and this suggestion tallies with the provisions of the national policy on environment. According to the Nigerian National Policy on Environment, the implementation should take into account historical, social, legal, and cultural factors into account more especially when searching for solutions to the environmental problems (Federal Ministry of Environment, 2014). Nevertheless, the adequacy of the legislations in incorporating the socio-cultural realities of the Nigerian societies is a subject beyond the scope of this research, and is part of the recommendation for future research. Nevertheless, the aim of the *National Environmental (**Construction Sector)** Regulations, 2010. S. I. No. 19* as stated by Ladan (2012) is centred on minimising pollution from construction, decommissioning, and demolition activities rather than materials conservation.

7.5.5 RE: Avoiding the Trend of the Economically Advanced Countries.

Once more another participant thought that, could the society avoid the unsustainable development trend of the economically developed countries more especially when the issues of standardisation and legislation are addressed? This was discussed in section 7.3.3 above. It was argued that with proper awareness, and different socio-cultural settings, the mistake of the west can be avoided by the east; more especially considering the fact that the whole of humanity occupies one and the same earth and there is no other alternative home for any of us to live! Sustainability is in the collective interest of all, or in the words of Goodland and Daly (1996) Sustainability is *"universal and non-negotiable"*.

Moreover, there are on-going researches and efforts for reusing building materials in construction such as the recycle aggregates in concrete, new life for an old wood, the mission of the American Construction and Demolition Recycling Association, private corporations (Brito & Saikia;

Construction & Demolition Recycling Association, 2016; Fast, 2001; Kibert, 1993; Pacheco-Torgal et al., 2013; Sassi, 2008). It can further be argued that the new trend in the economically advanced countries is shifting towards sustainable practices including the reuse of building materials. Therefore, if the developing countries must follow the trend of the developed countries, why must it be the old unsustainable trend rather than the emerging sustainable trend?

7.5.6 Energy Consumption in Reusing Materials.

A participant at the workshop noted that reusing materials might be associated with some use of energy which is not good for sustainability. However, there is always energy demand for materials in use, irrespective of the source of the material; either made fresh of raw materials extracted from the reserves of natural resources, recycled, or being reused. On the other hand, the energy used in upgrading and refurbishment of materials for reuse is less likely to be comparable with the energy consumed in manufacturing from materials extracted from natural resources or recycling.

7.6 Conclusion and Link

In this chapter, the validity of the conceptual model as a true representation of the reality has been demonstrated through a focus group discussions organised as two workshops. The acceptance of the participants of the model as correct representation and the responses and contributions to the model prove the reliability, sufficiency, clarity, simplicity, and usefulness of the model.

Furthermore, the responses of the participants of the workshop contributed significantly to the conclusion, impacts and recommendations in this research as will be presented in the next chapter 8.

Chapter 8 :Conclusion and Recommendation for Future Works:

8.1 Introduction

The construction industry is usually challenged for being conservative and inefficient more especially if compared with the other industries like manufacturing, and there has been the urge for improved efficiency (Egan, 1998; Latham, 1994).

Unlike manufactured products, every building is in the words of Koskela (2000) *"one-of-a-kind"* product that is different from any other of its type, made up of large quantities and wide range of constituents. While the construction industry is considered as a "conglomerate of industries" characterized by many inadequacies and paradoxes (Koskela, 2000; Solís, 2009), it is often described as less receptive to innovations and characterised by wide segregation of duties with unsteady workforce (Kibert et al., 2000). Moreover, the industrial culture inherent in the construction industry can be yet another influential cultural orientation comparable to national or organisational cultural orientation (Brockmann & Birkholz, 2006), which makes it even more conservative than the other sectors. These perceived shortcomings of the construction industry are often used as a justification for the need of the construction industry to learn lessons from other sectors like manufacturing.

The desirability of construction learning from other sectors was tabled for over 2 decades in the UK as contained in the reports of Latham (1994) and Egan (1998).

Efforts compliant with this line of thought predate the Latham and Egan reports; Sanvido and Medeiros (1990) for instance proposed an abstract model for integrated building process that imitates the corresponding computer-integrated processes used in manufacturing. These processes were broken down into business and management processes required to justify the provision of a building facility; then defining owners need and the methods for realizing those goals, and then providing the technical documentation necessary for the construction and tendering activities. Thereafter, the construction and operation phases of the facility (Sanvido & Medeiros, 1990).

One other instance of such efforts to apply the idea of the construction industry learning from manufacturing is when Koskela (1992) examined the Japanese lean production philosophy that was successfully used in the manufacturing of cars with improved performance and proposed transfer of the new production philosophy into construction. He argued that the traditional transformation concept used as a basis for planning and scheduling tasks in construction projects can be enhanced when production is viewed as a flow whereby non-value adding activities, otherwise considered as wastes, are recognized and eliminated as applied in the manufacturing industry (Koskela, 1992). In his later work in search of a production theory for the construction industry, Koskela (2000) developed a hybrid production theory referred to as the TFV model whereby production is viewed as comprising all of transformation, flow and value. This new production theory later to be known as lean construction is now the trending paradigm in construction, and according to Ranta (1993) it is now compelling for the construction industry to tread the path of other industries for increased efficiency, control, quality, productivity, and minimum cost of production (Solís, 2009).

Despite buildings being a form of art with longer and uncertain lifespan and different from the other sectors, this thesis seeks to explore the best practices of the end-of-life management of materials in other sectors and its implications on the practices of the end-of-life management of materials in the Nigerian construction industry. This was based on the premise that the construction industry should learn as much as possible from others who have done it elsewhere.

The aim of this study though, was to develop a conceptual ethnomimicry model of the practice of the end-of-life management of buildings in Nigeria. This is to provide a better understanding of the Nigerian practices and the implications of the best practice models from other sectors.

The objectives of this research were therefore:

1. To gain a theoretical knowledge and understanding of the position of construction and material waste in the sustainability agenda in general, and the construction demolition waste in particular, (achieved in chapter 2: Comprehensive Literature Review).

2. To explore best sustainable practice models of the end-of-life management of materials in different sectors, (achieved in chapter 3: Systematic and exploratory literature review).

3. To formulate a methodology for investigating the practice of the end-of-life management of buildings in Nigeria (achieved in chapter 4: Research Methodology and Design).

4. To investigate the implications of sustainability and best practice models on the Nigerian practice of the end-of-life management of buildings (achieved in chapter 5: The Practices of the End-of-life Management of Buildings in Nigeria).

5. To develop and validate a conceptual model for the Nigerian practice of the end-of-life management of buildings (achieved in chapters 6 and 7: Development and Validation of a Conceptual Model).

8.2 Research Findings

8.2.1 Objective 1: Summary of Findings from Literature Review I- Built Environment and Sustainability.

The combined impacts of human activities on the natural environment, including the emission of the greenhouse gasses into atmosphere and global warming, damage to the ecosystem and vegetation cause by acid rains and other complex chemical processes, deforestation, unsustainable exploitation of fresh waters and natural resources are approaching the limits of the capacity of the planet. And according to the influential report for the Club of Rome, is either for humanity to adjust to sustainable methods voluntarily or will be forced by natural constraints with undesirable consequences (Meadows et al., 1972). The emergence of even more revealing evidences on the limit of the carrying capacity of the earth climaxed with the international initiatives on sustainable development and the prominent report of the World Commission on Environment and Development known as the Brundtland's Commission (Brundtland, 1987). The developing countries were initially apprehensive of the sustainability initiatives, nevertheless, it was later accepted as a world agenda to pursue development in a sustainable pattern (NAJAM, 2005); until it becomes man's major programme for the 21st Century (RIBA, 2009b).

Natural resources depletion is one of the major issues in the sustainability agenda. This is especially emphasized considering the unsustainable linear trend of resources extraction, production, distribution, consumption, and disposal is considered (Leonard, 2010), or what McDonough and Braungart (2009) describe as cradle-to-grave consumption. The sustainable antidote to the unsustainable use of resources is reclaiming the materials back into the economic cycle by reducing the generation of waste, reuse, and recycling of materials in hierarchical order of preference, or what would be described as cradle-to-cradle (McDonough & Braungart, 2009).

The construction industry is reported as the largest consumer of the natural resources, and therefore important in the discussion of the natural resources depletion. This is further aggravated by the report of the enormous quantity of wastes generated from construction and demolition activities more especially in the economically developed countries (Kibert, 2005; Osmani, 2012; UK Green Building Council, 2013).

Meanwhile, the construction industry is renowned to be exceptional and lagging behind other sectors in different aspects. The construction industry is often described as complex with inefficient operations, fragmented specialized activities that are loosely interrelated with over lapping and long lead times. Frequent variations, conflicting loyalties, and repetitive defective work are the other characteristics of the industry. These features hinder increased efficiencies; control, quality, productivity, and production cost akin to manufacturing (Solís, 2009). And it was argued and demonstrated that the construction industry can learn from other sectors (Egan, 1998; Koskela, 1992; Latham, 1994).

8.2.2 Objective 2: Summary of Findings from Literature Review II- Best Practice Models of Sustainable End-of-life Management of Materials in Different Sectors.

Probably the most successful implementation of the idea of construction learning from other sectors is in the seminal work of Koskela (2000) in the area of operations management whereby the automobile (Toyota) production theory was adopted to construction. This was to be known as the lean construction which advocates the three paradigms composite model of production referred to as *Transformation-Flow-Value* (TFV) theory (Koskela, 2000) (see section 3.1). While the lean construction proliferates into different aspects to become the trending issue in the construction industry (Bertelsen & Koskela, 2004), there has not been a commensurate efforts to transfer sustainable practices from other sectors into the construction industry. It is in an effort to bridge this gap that some other industries were explored to identify best practices for the end-of-life management of materials in this research. The industries include the automobile, aviation, and ship industry; others are cell phone, nuclear and natural ecological systems.

There are four good practices the construction industry can learn from the automobile industry in sustainable management of materials. The dismantling, shredding, and materials separation stage is an example of a sustainable practice that can be transferred to the construction industry. This involves careful disassembly of components for reuse and segregation of similar items that may need to be broken-down into pieces for recycling.

Secondly, in the automobile industry the separation and marketing of reusable parts is another credit of the automobile worthy of emulation in the construction industry. This extends the lifecycle of products and is recognised as a technique of avoiding waste, considered to be the most sustainable waste management practice according to the waste hierarchy.

The third practice in the automobile industry that can be considered in the construction industry is the special treatment given to hazardous materials at the dismantling stage of automobiles. This is a good practice that should be observed in the construction industry.

And fourthly is the group of other practices in the automobile industry that can be adopted into the construction industry including design for deconstruction, simplified mechanical assembly-disassembly, materials combination, materials' identification and standardisation.

The aviation industry on the other hand, exhibits a good example of producer responsibility as demonstrated by the duopoly rivals, the Airbus and Boeing. While the Airbus established a joint venture enterprise to manage retired aircrafts using a demonstration project called "*The Process for the Advanced Management of End of Life of Aircraft*" abbreviated as PAMELA, a professional association (The Aircraft Fleet Recycling Association- AFRA) was formed by Boeing as a facilitator and an associate member. The construction industry can learn from this practice by making producers of building materials responsible for the end-of-life management of materials. Nonetheless, the relatively longer lifespan of buildings may make this practice more challenging in the construction industry.

Another sustainable practice in the aviation industry is avoiding waste by extension of the life cycle of products through the change of use, such as the conversion of an aircraft into a hotel, or the use of the aircraft furniture for other purposes (see section 3.3).

In the shipping industry the good sustainable practices include the prescribed standardisation by the International Standard Organisation: The ISO 30004 ship recycling management model and the (International Maritime Organisation-IMO) requirement for ships to carry and maintain installed materials property labels throughout their life cycle. The ISO 30004 is a standardised procedure for the end-of-life management of ships for compliance by all operators in the industry. If the construction industry is to adopt these practices, a standard procedure for decommissioning all buildings will be required in addition to maintaining material database and labels on all building components.

The lessons from cell phones industry on the other hand include profitability. The end-of-life management of cell phones is largely driven by profitability rather than legislation. There are third party enterprises that handle the reverse logistics of recovering handsets for reuse or recycling which are considered as sustainable practices. The collection methods used in reclaiming handsets back into the economic cycle are worthy of emulation in the construction industry. The collection methods include drop-off bins, return incentives, and buy-backs.

The nuclear industry can teach the construction industry the benefit of using a comprehensive decommissioning plan from the initial construction stage. It is usually a mandatory requirement for issuing a construction licence. This implies, if this idea is to be adopted in the construction industry, a decommisisioning plan will be required prior to issuing a building permit. Another practice in the nuclear sector which commence from the initial stage is generating the funds to finance the decommissioning of facilities. Nonetheless, this can only be applicable in the construction industry when the demolition of buildings involves large expenditure and the market value of the salvaged materials cannot upset the cost.

Probably the natural ecological sector is the best example in the sustainable use of materials. In the natural systems, materials are used in a closed-loop whereby wastes in one process becomes the raw material for another process. In these balanced systems, there is usually zero waste. Members in the natural ecological systems are organised in a mutually symbiotic arrangement to use materials in the most efficient manner, and generate zero waste. The idea of organising the human industrial activities to resemble the natural ecological system been a well-developed discipline referred to as the industrial ecology. There was a proposal for extending the concept of the industrial ecology into the construction industry as construction ecology for over a decade as advocated by Kibert et al. (2000).

8.2.3 Objective 3: Analysis of the Research Methodology

A case study strategy was described as suitable for the study of current real life situations whereby the context and the subject seems similar and the researcher largely has no control over events (Yin, 1981, 2009). Case study research was further described as an intensive, holistic description and analysis of a phenomenon such as a program, an institution, a person, a process, or a social unit (Grünbaum, 2007). Characteristically, case study involves the study of people and their interpretations of a phenomenon, which is usually holistic and contemporary. It is usually qualitative, descriptive, exploratory, or explanatory in nature, and comfortably answers the *"how"* and *"why"* type questions. The development of theory prior to data collection distinguishes case study from ethnography, and the theoretical proposition usually guides the data collection. Case study is therefore considered most appropriate strategy in this inquiry that is considered descriptive, exploratory, and explanatory in nature.

A single-case embedded multiple units of analysis case study design was used in this study. There is a long standing discrepancy between authors about what distinguishes a unit of analysis and a case (Grünbaum, 2007). According to Merriam (1988) what constitutes a case in a case study strategy can be considered to be an occurrence of a bounded system such as a person, program, institution or social unit, while a unit of analysis can be described by as the focus of the study or the central issue addressed by the research (Grünbaum, 2007). In this study the city of Kano is considered as the case, while the reuse of salvaged building materials and the role of the stakeholders is considered as the unit of analysis.

The theoretical predisposition in this study was developed from the sustainability concepts and best practice models of the end-of-life management of materials in different sectors, the data was collected using an in-depth interview. The research participants on the other hand, were purposely selected or nominated by other participants in a snowball fashion guided by a stakeholder grouping system. The quality of the study site, which is representative of atypical Nigerian city, and the detailed approach in investigating the phenomenon paved the way for application in different context and can influence future generalisations. Moreover, the documentation of the research procedures enables repetition of the research and the possibility of obtaining similar or different results, and therefore establishes a theoretical procedural generalisation. The quality of the research participants and the description of the study site makes it a typical case and qualifies it for argumentative generalisation (Mayring, 2007).

The case study strategy deployed in this research satisfactorily provides the tool for the development of a conceptual model of the end-of-life management of buildings in Nigeria. Semi-structured interviews were used to obtain information about the phenomenon; the questions were structured to reflect the best practice models in different sectors while template analysis was used to analyse the data. The data was interpreted to develop a conceptual model, which was validated using two focus group workshops. Though the discussion was moderated by a third party in a manner that was slightly different from the procedure for conducting focus group as recommended by Rabiee (2004).

Moreover, as some of the research participants were part of the workshop, it provided an opportunity for member checking. Additionally, the role of the academic advisor to the researcher was a form of a Peer debriefing. The combination of the elements of focus group, member checking, and peer debriefing was therefore used in the validation of the findings and interpretations in this study.

8.2.4 Objective 4: The Implications of Sustainability and Best Practice Models on the Practices of the End-of-life Management of Buildings in Nigeria.

There are practices inherent in the Nigerian tradition of the end-of-life management of buildings that were coincidently discovered to be compliant with the sustainability principles. These include the processes of building decommissioning, materials sorting, waste generation, the stakeholders, finance and profitability, and wastes avoiding practices.

The processes used in demolition of buildings were targeted at salvaging the materials for reuse or sales, and sometimes creatively utilised on the same site for a new structure. This coincides with the practices in automobile industry and the aviation sector as discussed in sections 3.2 and 3.3, whereby materials from a retired locomotive are encouraged to be recovered for reuse in similar or different purpose. The salvage of the materials starts with the disassembly and sorting of the materials according to the need for reuse and minimising damage to the materials. As discussed in section 2.6, the exemplary reassembly of Crystal Palace in a different location in London in 1854, after it was first assembled in 1851 for an exhibition at Hyde Park is a recurring phenomenon in Nigeria.

Contrary to the assumption that the construction industry is behind and should learn from other industries, the findings of this research indicated that in Nigeria there is virtually zero demolition waste. And the organisation and roles of the stakeholders, reveal that the industry is organically structured to handle the salvaged materials from building demolition so as to recover as much as possible back to economic cycle. The industry is organised in the like of the natural ecological system whereby the wastes from one process becomes the raw material for another. This coincides with the requirements of the sustainable waste management systems.

The marketability and profitability of dealing with the salvaged materials contribute to the emergence of third party enterprises in charge of the reverse logistics for reclaiming materials back into the economic cycle. This resembles the tradition in the cell phone industry whereby the third party enterprises are responsible for the reverse logistics of recovering retired cell phones back for reuse or recycle.

The reuse of the materials is on the border between the best and second best sustainable practices of managing waste according to the waste hierarchy. When a material is reused without any upgrade, then it falls into the category of waste avoidance and which is considered the most sustainable waste management strategy; and where the material is upgraded before it is reused, it falls into the second most sustainable waste management strategy (see section 2.5.2). Another trait of waste avoidance found in Nigeria is the prolonged lifespan of building structures. In most cases the lifespan of buildings is as long as it remains safe for use.

On the other hand, as discussed in section 5.8 there are challenges facing the Nigerian sector of the end-of-life management of buildings, which need to be improved. These include standardisation, material database, specialised tools, awareness, policies and legislations, and professionalization. It is to be noted that the developed ethnomimicry conceptual model in this research aims to capture the process of the end-of-life management of buildings in Nigeria, as a means to formally document the zero demolition waste practice so that relevant and applicable lessons can be explored and applied in other contexts.

8.2.5 Objective 5: Develoment and Validation of the Conceptual Model

Increased pressure on the world's finite resources due to increased demand due to population growth, industrialisation efforts in the developing countries, and the consumerism culture of the developed countries make the development of the conceptual model of systems considered more sustainable even more imperative. In the public and academic literature, the solid waste management systems in the developing countries is dismissed as "informal" and associated with many inadequacies such as child labour, health and safety issues, tax evasion, political tussles, pollution, and incompatibility with the image of a modern city, while overlooking its potentials in providing essential services, providing jobs, and payment of tax.

In this study *"books were closed and eyes opened"* (De Soto, 2000), to provide a polemic view of the otherwise "informal" sector as sustainably good practice model for the end-of-life management of buildings. A conceptual model will provide a documentation and improved understanding of the factors responsible for the thriving of this practice.

According to Covin and Slevin (1991), a conceptual model usually illustrates the interrelationship between the constituent variables. It is usually in a form of a diagram showing the relationships of the factors considered to lead to a condition (Koskela and Kagioglou 2007). The conceptual model in this study was developed in three stages, first by identifying the factors, then to establish the interrelationship of the factors, and thirdly the outcome produced from the interaction of the factors.

The concept of the model was developed from the biomorphic imitation of the structure of an African snail and the Process Protocol (Lee, 2002). The idea of soft and hard gate as the conceptual decision making stage whereby a condition must be satisfied before passing through the hard gates. There are three conceptual hard gates in the model that ensure that materials are filtered to minimise waste generation. The hard gates also ensure that as much material is reused and only recycled when necessary. The second gate ensures that only materials that cannot be recycled are allowed to be used for energy generation, while another gate filters the materials to ensure what goes to the landfill cannot be use to generate energy. This is a conceptual filter that depicts the real-life situation of the lifecycle of building materials in the Nigeria. It illustrates the sustainability principles and the waste hierarchy in practice.

The feedback from the workshop participants confirms that the conceptual model truly represents the real life situation of the end-of-life management of buildings in Nigeria, which is a testimony that this objective (development and validation of a conceptual model) was achieved. Moreover, the participation of some of the research participants in the workshop provided an opportunity for “member checking” as another approach to the validation of the research findings and interpretation.

8.3 Research Novelty

The construction industry is usually associated with many inadequacies and paradoxes; and there are arguments that for increased efficiencies, control, quality, and productivity, the construction industry should learn from other industries. There were successful efforts to transfer concepts from other industries to the construction industry, with the most prominent of such efforts probably being the concept of lean production system as lean construction. Nevertheless, the idea of adopting sustainable practices in the end-of-life management of materials from other industries to the construction industry is explored for the first time in this study.

This study provides an insight and documentation of the practices of the end-of-life management of buildings in Nigeria and its relevance to the sustainability principles for the first time. Traditionally the solid waste management sectors in the developing countries are considered as informal and overwhelm by problems; this study rather provides a polemic perspective of the sector whilst emphasizing its merits.

On the other hand, while acknowledging the potentials of the system, the shortcomings of the Nigerian practice were identified. The potentials were recognised as possible inspirations for developing a model for an improved sustainable system of the end-of-life management of buildings; and a proposal was made on the ways to improve the shortcomings of the practices.

The development of the conceptual model that represents the real-life situation of the Nigerian practice of the end-of-life management of buildings provides a one-stop illustration that explains the factors and processes of materials economics. The use of a natural form as a concept for the illustration is a testimony to the undisputable position of nature as the best teacher for sustainable solutions.

Furthermore, the acceptance of natural systems as the most sustainable is extended by the introduction of the idea of "ethnomimicry" as an approach for getting inspirations from the models of the native societies that have always survive by living in harmony and respect for nature. This study provides an insight into an aspect of the practices of one of the native societies that is in harmony with the nature.

8.4 Limitations of the Research

As with other studies in a natural setting it is nearly impossible to replicate a research (Wiersma, 1985). On the other hand, it is more difficult in case study researches to establish causal inferences and generalisations. Behaviour of one entity may only be suggestive of what may be found in other similar entities, with generalisation becoming less suitable.

The case study strategy used in this study, time and resources constraints in a cross-sectional study of this nature, resulted in all the research participants and the data collected from Kano city as a unit of analysis, which was considered to be representative of a typical Nigerian city. However, the research findings are only suggestive of the situation in the larger context of Nigeria. The generalizability of the findings may require confirmation from further investigations. The generalizability of the research findings for the whole of Nigeria according to the traditional positivist scientist stance, may not be feasible. However, in a qualitative descriptive and explorative studies of this nature a phenomenon is studied broadly to be applicable in different context and develop general statements that can influence future generalisations (Mayring, 2007). In this situation, the research procedures are well documented to enable repetition of the research and the possibility of obtaining similar or different results, and therefore establish a theoretical procedural generalisation. The quality of the research participants and the description of the study site makes it a typical case and qualifies it for argumentative generalisation (Mayring, 2007).

Some of the research participants could not speak in the English language, and consequently, the invitation to participate, the participant information sheet, consents form, and interview guide had to be translated into the native Hausa language. In addition, some recordings from the interviews had to be translated to English; where words such as “Yangwangwan could not be directly translated, its original form was used. As the researcher is a native Hausa speaker and was akin to technical words specific to the discipline, this presented no issues to the research. However, some participants were apprehensive about legality and negative perception to their responses; and in a number of cases some potential participants declined to participate in the research.

The qualitative analysis of the data could have been enriched by statistical analysis of the building materials after demolition to give another insight into the prevalence of reuse, recycling, and other techniques of waste management. Nonetheless, due to time and resources constraints that could not be accomplished. This approach is however recommended for further studies of the end-of-life management of buildings in Nigeria.

Alternatively, longitudinal studies involving prolonged observations and contact with the subjects would have provided an opportunity for validating some of the information provided by the research participants. Longitudinal studies are usually attributed to increased internal validity as discussed by (Leonard-Barton, 1990).

The data collected for this research is limited to buildings in the use category groups F (institutional), H (residential) and J (mixed use and occupancy) according to the Nigerian National Building Code classification. These buildings are typically constructed from cement products, steel, stone, aluminium, timber and ceramic materials all over Nigeria.

8.5 Recommendations for Future Work

As every research is time and context specific, this study can be expanded further by investigating the implications of the best practice models of sustainable end-of-life management of materials in different sectors on the construction industry in different context. The source of the data and the interpretation are limited to the Nigerian context. The socio-cultural, and economic settings of the Nigerian construction industry is unique and distinguishable from that of every other country, most especially the economically advanced countries. Additionally, it has been argued that management theories that work in one country may not work in another, even within the economically developed nations (Hofstede, 1980); and the validity of this assertion on the end-of-life management of buildings can be verified by repeating similar research in a different cultural context. The study can also be repeated in similar cultural context for confirmability of the findings.

On the other hand, adopting statistical approach, whereby the wastes from building demolition in Nigeria can be analysed to establish the exact arithmetical proportion of the materials that are reused, recycled or treated otherwise can expand this research further. This may require a longitudinal study involving multiple sites and tools.

A comparative analysis of profitability between recycling and reuse in the Nigerian C&D salvaged products is another area that this research can be expanded.

Furthermore, the adequacy of the Nigerian environmental laws in incorporating the historical, social, legal, and cultural factors is another inquiry for further investigation.

Another way of expanding this research is the development of a prescriptive framework for the end-of-life management of buildings inspired by the principles of the Nigerian model.

8.6 Final Note: from Biomimicry to Ethnomimicry

"Between now and 2050 I think biomimicry is going to be one of the main tools that will facilitate the transition from the industrial age to the ecological age of mankind…" Peter Head in (Pawlyn, 2011)

As discussed in section 3.7, the renowned proponent of *"Biomimicry"* (Benyus, 1997), defined it as a science of imitating the designs and processes of nature to solve human problems, while using ecological standards for the judgement of human innovations. According to this paradigm, nature is regarded as a teacher to learn from rather than a source of resources for extraction. The need for such approaches as *Biomimicry* becomes even more compelling as humans realised that our industrial activities may be approaching the threshold of the bearing capacity of the planet earth.

Other living organisms have virtually recorded as much achievements as humans without depleting the natural resources, or poisoning the environment to the extents of threatening their future; achievements that are worthy of emulation by humans (Benyus, 1997; Pawlyn, 2011, p. 1). Beyond the Wright Brothers' mimicry of the birds flying techniques, there is a long list of successful imitation of nature to solve human problems more sustainably in engineering, industrial design, fashion design, and medicine. This includes a solar cell modelled after leaves, a spider-style woven fibre, ceramics inspired by mother-of-pearl, cancer cures learned from the chimpanzees, or a computer signals fashioned in the way of the cells (Benyus, 1997).

Biomimicry was the inspiration for developing many concepts in the built environment as documented by (Pawlyn, 2011). An Italian engineer Pier-Luigi Nervi successfully achieved lightweight long-span concrete roof of Palazzeto dello Sport in Rome by imitating the structural principles of the radial rib structure of the leaves of the Amazon water lily. The spider web inspired the West German Pavilion at the 1967 Expo at Montreal designed by Frei Otto. Otto made extensive publications on structural principles inspired by nature. Another class of structures inspired by biological principles is the deployable structures that change shapes in response to the external conditions. An example of this type of structures is the retractable umbrellas of the Holy Mosque of the Prophet at Medina in Saudi Arabia and Al-Husayn Mosque in Egypt, designed by Frei Otto's disciple Mahmood Bodo Rasch. Moreover, there are examples of biologically inspired technology for construction materials production, water management, energy production, and thermal control. However, the most relevant to the discourse of this study is the creation of a closed-loop economy in the style of the natural ecosystems as in the redwoods, coral reefs, or forests that produce zero wastes (Benyus, 1997; Pawlyn, 2011).

While there is on record preindustrial societies that collapsed form unsustainable practices, as discussed in section 3.7, there are many more cultural practices and belief systems of tribal societies that are friendly to the sustainability concepts that are worthy of notice. As alluded by Benyus (1997, p. 1), it is now an extraordinary time that urban westerners should learn from the wisdoms of the preindustrial societies on how to live in harmony and sustainably on earth. Benyus (1997) went further to say:

" ...Virtually all native cultures that have survived without fouling their nests have acknowledged that nature knows best, and have had the humility to ask the bears and wolves and ravens and redwoods for guidance. They can only wonder why we don't do the same. ...After three hundred years of western science, was there anyone in our tradition able to see what the Huaorani see?"

There were successful simulations of nature by western science to develop technological innovations for human benefits. However, there is little done to advance the humility to learn from the societies that live within the natural order. On the other hand, if biomimicry refers to the humility to learn lessons from the nature, what about the humility to learn lessons from the selective successful native societies on how to live in harmony with the nature; or rather, how to live within the natural order as our co-living organisms. This is referred to as *ETHNOMIMICRY.* Ethno from the Greek *ethnos*, race or people, and mimesis, imitation (*The American heritage dictionary of the English language*, 2000; Benyus, 1997).

Biomimicry was defined as the new science that studies nature's models and then imitates or takes inspiration from these designs and processes to solve human problems (Benyus, 1997). Another definition of Biomimicry is "mimicking the functional basis of biological forms, processes and systems to produce sustainable solutions" (Pawlyn, 2011). *Ethnomimicry* can therefore be defined as, *the systematic study of the models of the native societies for imitation or inspiration to develop sustainable solutions.*

One area with the potentials for such studies is the Nigerian end-of-life management of buildings, which is the subject of this study. The near perfect construction ecology that is a by-product of natural consequences in the Nigerian practice of handling the demolition of buildings as investigated in this research is relatively more sustainable than the common practices in the developed countries. Moreover, such sustainable practices emerge "naturally" without significant efforts in terms of legislation or any regulatory instruments as in the developed countries. The task beforehand is to explore the derivers for the emergence of such practices and examine the feasibility of getting an inspiration for developing a sustainable system with wider application. This can be achieved using the concept of ethnomimicry as elaborated in this note.

LIST OF REFERENCES:

Adamu. (2006). Loud bubbles from a silent brook: Trends and tendencies in contemporary Hausa prose writing. *Research in African literatures, 37*(3), 133.

AFRA, A. F. M. A. (2009). Best Management Practice for Management of Used Aircraft Parts and Assemblie. (2).

Agency Report. (2015, 22 May, 2015). Africans Task China On Fake, Sub-Standard Products In African Markets. *Leadership*. Retrieved from http://leadership.ng/news/435334/africans-task-china-on-fake-sub-standard-products-in-african-markets

Agenda, U. (1992). *21. 1992.* Paper presented at the United Nations Conference on Environment & Development Rio de Janerio, Brazil, June.

Aigbokhan, B. E. (2000). *Poverty, Growth, and Inequality in Nigeria: A case study* (Vol. 102): African Economic Research Consortium.

Airbus. (2008). Process for Advance Management of End-of-Life of Aircraft. *Eco-efficiency and Sustainability*.

Aiyedogbon, J. O., & Ohwofasa, B. O. (2012). Poverty and youth Unemployment in Nigeria, 1987-2011. *International Journal of Business and Social Science, 3*(20), 269-279.

Akeju, A. A. (2007). *Challenges to providing affordable housing in Nigeria.* Paper presented at the Proceedings of 2nd Emerging Urban Africa International Conference on Housing Finance in Nigeria.

Allenby, B. R., Richards, D. J., & National Academy of Engineering. (1994). *The greening of industrial ecosystems*. Washington, D.C.: National Academy Press.

The American heritage dictionary of the English language. (2000). H. M. Company. (Ed.) (pp. 1 CD-ROM). Retrieved from http://www.thefreedictionary.com/ethno-

Anumba, C. (2004). *Health and safety in refurbishment involving demolition and structural instability*. Sudbury: HSE Books.

Aouad, G., Hinks, J., Cooper, R., Sheat, D., Kagioglou, M., & Sexton, M. (1998). Map for a generic design and construction process protocol. *Journal of Construction Procurement*.

Apple, I. (2013). Recycling. Retrieved from http://www.apple.com/recycling/

Aronson, J. (1995). A pragmatic view of thematic analysis. *The Qualitative Report, 2*(1), 1-3.

Atkinson, P., & Hammersley, M. (1994). Ethnographyand participant observation. *Handbook of qualitative research. Thou-sand Oaks, CA: Sage*.

Baker, S. E., & Edwards, R. (2012). How many qualitative interviews is enough.

Banham, R. (1969). *The architecture of the well-tempered environment*. London: Architectural P.

Barnett, H. J., & Morse, C. (2013). *Scarcity and growth: the economics of natural resource availability* (Vol. 3): Routledge.

Bartl, A. (2014). Ways and entanglements of the waste hierarchy. *Waste Management, 34*(1), 1-2. doi:http://dx.doi.org/10.1016/j.wasman.2013.10.016

BBC. (2014). Nigeria's Boko Haram crisis: Kano suicide attack. Retrieved from http://www.bbc.co.uk/news/world-africa-27465113
Belogolovsky, V. (2009). *Green House*. Russia: TATLIN PUBLISHERS.
Benyus, J. M. (1997). *Biomimicry : innovation inspired by nature*. New York: Morrow.
Berge, B. (2009). *The ecology of building materials* (2nd ed. ed.). Amsterdam ; Oxford: Elsevier/Architectural Press.
Bertelsen, S. (2003). *Construction as a complex system.* Paper presented at the proceedings of IGLC.
Bertelsen, S. (2004). Lean Construction: Where are we and how to proceed. *Lean Construction Journal, 1*(1), 46-69.
Bertelsen, S., & Emmitt, S. (2005). *The client as a complex system.* Paper presented at the Proceedings of the 13th Annual Conference of the International Group for Lean Construction, Sydney.
Bertelsen, S., & Koskela, L. (2004). *Construction beyond lean: a new understanding of construction management.* Paper presented at the Proceedings of the 12 th annual conference in the International Group for Lean Construction.
Bhardwaj, V., & Fairhurst, A. (2010). Fast fashion: response to changes in the fashion industry. *The International Review of Retail, Distribution and Consumer Research, 20*(1), 165-173.
Biospherics. (2013). Information on Biospherics, Biosphere 2, Vernadsky, Biosphere Publications, Books and Conferences. Retrieved from http://www.biospherics.org/index.html
Bishop, O. N. (1973). *Natural communities*. London: J. Murray.
Blaikie, N. (2007). *Approaches to social enquiry* (2nd ed. ed.). Cambridge: Polity.
Boeing. (2007). Aircraft Recycling. Retrieved from **Error! Hyperlink reference not valid.**
Boeing. (2013). End of Sevice is not End of life. Retrieved from http://www.newairplane.com/environment/ - /AirplaneProductionAndRecycling/Recycling
Boothroyd, G., & Alting, L. (1992). Design for Assembly and Disassembly. *CIRP Annals - Manufacturing Technology, 41*(2), 625-636. doi:http://dx.doi.org/10.1016/S0007-8506(07)63249-1
Bormann, F. H. (1981). The Gaia Hypothesis. *Ecology, 62*(2), 502. doi:10.2307/1936729
Boyden, S., & Dovers, S. (1997). Humans in the biosphere. *Human Ecology, Human Economy: Ideas for an Ecologically Sustainable Future, Allen & Unwin, Sydney*, 3-34.
Boyle, D. (2014, 19/07/2014). Everything must go! Chaos as contents of disused shopping centre are sold off for a song - and people start ripping televisions and even CCTV cameras off the walls. *Mail Online*. Retrieved from http://www.dailymail.co.uk/news/article-2698367/Everything-Chaos-contents-disused-shopping-centre-sold-song-people-start-ripping-televisions-CCTV-cameras-walls.html - ixzz384PzQazi

Brandon, P. S., & Lombardi, P. L. (2011). *Evaluating sustainable development in the built environment* (2nd ed. ed.). Oxford: Wiley-Blackwell.
bre. (2017). BREAM. Retrieved from http://www.breeam.com/
Brito, J. d. a., & Saikia, N. a. *Recycled aggregate in concrete : use of industrial, construction and demolition waste*.
Brito, J. d. a., & Saikia, N. a. (2013). *Recycled aggregate in concrete : use of industrial, construction and demolition waste*.
Brockmann, C., & Birkholz, A. (2006). *Industry culture in construction and manufacturing.* Paper presented at the Joint International Conference on Construction Culture, Innovation and Management (CCIM), Dubai, UAE.
Brooks, J., & King, N. (2014). Doing Template Analysis: Evaluating an End of Life Care Service. *Sage Research Methods Cases*.
Brown, L. R. (2001). *State of the world 2001 : progress towards a sustainable society*. London: Earthscan.
Brown, L. R., Flavin, C., & French, H. (2000). State of the World. *Worldwatch/Earthscan, London*.
Brundtland, G. H. (1987). *Report of the World Commission on environment and development:" our common future."*: United Nations.
Bryman, A. (2006). Integrating quantitative and qualitative research: How is it done? *Qualitative Research, 6*(1), 97-113. doi:10.1177/1468794106058877
Bryman, A. (2008). *Social research methods* (3rd ed. ed.). Oxford: Oxford University Press.
Bryman, A. (2009). The End of the Paradigm Wars? In P. Alasuutari, L. Bickman, & J. Brannen (Eds.), *The SAGE handbook of social research methods*. Los Angeles, Calif. ; London: SAGE.
Bryman, A. (2012). *Social research methods* (4th ed. ed.). Oxford: Oxford University Press.
BS30004:2012, B. S. I. (2012). Ships and marine technology — Ship

recycling management systems —

Guidelines for the implementation of

ISO 30000 *BS ISO 30004:2012*. Switzerland: BSI.
Buruiana, D. L., Bordei, M., Sandu, I. G., Chirculescu, A. I., & Sandu, I. (2013). Recycling waste grit in mix asphalt. *Materiale Plastice, 50*(1), 36-39.
Butlin, R. N., Yates, T. J. S., Murray, M., & Ashall, G. (1995). The United Kingdom national materials exposure programme. *Water, Air, and Soil Pollution, 85*(4), 2655-2660. doi:10.1007/bf01186235
Cabinet Office. (2013). Red Tape Challenge. Retrieved from http://www.redtapechallenge.cabinetoffice.gov.uk/environment/waste/
Callaway, B. J. (1987). Muslim Hausa women in Nigeria: Tradition and change.
Carberry, W. (2008). Airplane Recycling Efforts

Benefit Boeing Operators. *AERO, QTR_4.08*.

CDRA, C. D. R. A. (2016). Welcome to the CDRA. Retrieved from http://www.cdrecycling.org/
Chappine, P. (2015). Urbanization & Other Effects of the Industrial Revolution: Social & Economic Impacts. Retrieved from http://study.com/academy/lesson/urbanization-and-other-effects-of-the-industrial-revolution.html
Chattopadhyay, R., Slack, N. E., Canadian Electronic, L., & Forum of, F. (2009). *Finance and Governance of Capital Cities in Federal Systems*. Montréal [Que.]: Published for Forum of Federations/Forum des féderations by McGill-Queen's University Press.
Chilton, J. (2009). Designing Structures for Deconstruction. *Construction Information Quarterly, 11*(3), 127.
Cohen, J. E., & Tilman, D. (1996). Biosphere 2 and biodiversity: The lessons so far. *Science, 274*(5290), 1150-1151.
Construction & Demolition Recycling Association, C. (2016). Welcome to the CDRA. Retrieved from http://www.cdrecycling.org/
Costes, B. (2007). Layman Report (FR).
Covin, J. G., & Slevin, D. P. (1991). A conceptual model of entrepreneurship as firm behavior. *Entrepreneurship: Critical perspectives on business and management, 3*.
Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into practice, 39*(3), 124-130.
Cruz-Rivera, R., & Ertel, J. (2009). Reverse logistics network design for the collection of End-of-Life Vehicles in Mexico. *European Journal of Operational Research, 196*(3), 930-939. doi:http://dx.doi.org/10.1016/j.ejor.2008.04.041
Dania, A., Kehinde, J., & Bala, K. (2007). *A study of construction material waste management practices by construction firms in Nigeria.* Paper presented at the Proceedings of the 3rd Scottish Conference for Postgraduate Researchers of the Built and Natural Environment, Glasgow.
Darby, L., & Obara, L. (2005). Household recycling behaviour and attitudes towards the disposal of small electrical and electronic equipment. *Resources, Conservation and Recycling, 44*(1), 17-35. doi:http://dx.doi.org/10.1016/j.resconrec.2004.09.002
Dasgupta, P., & Heal, G. (1974). The optimal depletion of exhaustible resources. *The review of economic studies, 41*, 3-28.
Dasgupta, P. S., & Heal, G. M. (1979). *Economic theory and exhaustible resources*: Cambridge University Press.
De Soto, H. (2000). *The mystery of capital: Why capitalism triumphs in the West and fails everywhere else*: Basic books.
De Soto, H. (2001). Why Capitalism Works in the West but Not Elsewhere. *International Herald Tribune*. Retrieved from http://www.cato.org/publications/commentary/why-capitalism-works-west-not-elsewhere

Deci, E. L., & Ryan, R. M. (2000). The "What" and "Why" of Goal Pursuits: Human Needs and the Self-Determination of Behavior. *Psychological Inquiry, 11*(4), 227-268. doi:10.1207/S15327965PLI1104_01

DEFRA, D. f. E., Food and Rural Affairs (2011). *Government Review of Waste Policy in England 2011*.

Diamond, J. (2005). *Collapse: How societies choose to fail or succeed*: Penguin.

Diesendorf, M. (2000). Sustainability and sustainable development. *Sustainability: The corporate challenge of the 21st century, 2*, 19-37.

Dilanthi, A., David, B., Marjan, S., & Rita, N. (2002). Quantitative and qualitative research in the built environment: application of “mixed” research approach. *Work Study, 51*(1), 17-31. doi:10.1108/00438020210415488

DOE, D. o. t. E. (2012a). *Waste Management: The Duty of Care- a code of Practice for Northern Ireland*. Northern Ireland: Deparrtment of the Environment Retrieved from http://www.doeni.gov.uk/waste_management_duty_of_care_code_of_practice_for_ni.pdf.

DOE, D. o. t. E. (2012b). *Waste Management: The Duty of Care- a code of Practice for Northern Ireland* Northern Ireland: Deparrtment of the Environment Retrieved from http://www.doeni.gov.uk/waste_management_duty_of_care_code_of_practice_for_ni.pdf.

Eat Sleep Live Ltd. (2016). Modern Rustic Furniture. Retrieved from http://www.eatsleeplive.co.uk/

Egan, J. (1998). The Egan Report-Rethinking Construction. *Report of the Construction Industry Task Force to the Deputy Prime Minister. London*.

Ehrlich, P. R., & Ehrlich, A. H. (1989). *How the rich can save the poor and themselves; lessons from the global warming.* Paper presented at the International Conference on Global Warming and Climate Change Perspectives from Developing Countries,, New Delhi (India), 21-23 Feb 1989.

El Serafy, S. (1991). The environment as capital. *Ecological economics: The science and management of sustainability*, 168-171.

El Serafy, S. (1993). *Country macroeconomic work and natural resources*: World Bank, Environment Dept.

Eminton, S., Quinault, C., Date, W., & North, A. (2012). Defra reveals timetable for cutting waste red tape. Retrieved from http://www.letsrecycle.com/news/latest-news/legislation/defra-reveals-timetable-for-cutting-waste-red-tape

ENIE01, 21/09/2014). [INTERVIEW ONE].

ENIE02, 19/09/2014). [INTERVIEW TWO].

ENIE03, 28/09/2014). [INTERVIEW THREE].

ENIE04, 01/10/2014). [INTERVIEW FOUR].

ENIE05, 23/10/2014). [INTERVIEW FIVE].

ENIE06, 30/09/2014). [INTERVIEW SIX].

ENIE07, 28/10/2014). [INTERVIEW SEVEN].

ENIE08, 13/12/2014). [INTERVIEW EIGHT].
ENIE09, 17/12/2014). [INTERVIEW NINE].
ENIE10, 16/12/2014). [INTERVIEW TEN].
ENIE11, 17/12/2014). [INTERVIEW ELEVEN].
ENIE12, 16/12/2014). [INTERVIEW TWELVE].
ENIE13, 29/11/2014). [INTERVIEW THIRTEEN].
ENIE14, 20/01/2015). [INTERVIEW FOURTEEN].
ENIE15, 28/01/2015). [INTERVIEW FIFTEEN].
ENIE16, 29/11/2014-18/01/2015). [INTERVIEW SIXTEEN].
Environment. (2013). ENVIRONMENT - ECOLOGY - NATURE - HABITAT - GAIA - PERMACULTURE. Retrieved from http://www.environment.gen.tr/gaia/70-gaia-hypothesis.html - History
Environmental Law Institute. (2013). African Environmental Law and Policy-Nigeria. Retrieved from http://www2.eli.org/africa/nigeria.htm
Falola, T., & Achberger, J. (2013). *The political economy of development and underdevelopment in Africa* (Vol. 10): Routledge.
Farlex inc. (Ed.) (2013) renewable. (n.d.) WordNet 3.0, .
Fast, E. (2001). New life for old wood. *Environment*, *43*(2), 4-5.
Federal Ministry of Environment. (2014). National Policy on Environment. Retrieved from http://environment.gov.ng/index.php/downloads/6-national-policy-on-environment
Ferguson, N., & Browne, J. (2001). Issues in end-of-life product recovery and reverse logistics. *Production Planning & Control*, *12*(5), 534-547.
Frosch, R. A. (1992). Industrial ecology: a philosophical introduction. *Proceedings of the national academy of sciences*, *89*(3), 800-803.
Fuller, B. (2002). Science Quotes by R. Buckminster Fuller. Retrieved from http://todayinsci.com/F/Fuller_Buckminster/FullerBuckminster-Quotations.htm
García-Rodríguez, F. J., Castilla-Gutiérrez, C., & Bustos-Flores, C. (2013). Implementation of reverse logistics as a sustainable tool for raw material purchasing in developing countries: The case of Venezuela. *International Journal of Production Economics*, *141*(2), 582-592. doi:http://dx.doi.org/10.1016/j.ijpe.2012.09.015
Geert, H., & Jan, H. G. (1991). Cultures and organizations: Software of the mind. *McGraw-Hill, New York*.
Gelb, A., Kaiser, K., & Viñuela, L. (2012). How Much Does Natural Resource

Extraction Really Diminish

National Wealth?

The Implications of Discovery. Retrieved from http://www.cgdev.org/files/1426040_file_Gelb_Kaiser_Vinuela_extraction_FINAL.pdf

Geyer, R., & Doctori Blass, V. (2010). The economics of cell phone reuse and recycling. *The International Journal of Advanced Manufacturing Technology, 47*(5-8), 515-525. doi:10.1007/s00170-009-2228-z

Gharfalkar, M., Court, R., Campbell, C., Ali, Z., & Hillier, G. (2015). Analysis of waste hierarchy in the European waste directive 2008/98/EC. *Waste Management, 39*, 305-313. doi:http://dx.doi.org/10.1016/j.wasman.2015.02.007

Go, T. F., Wahab, D. A., Rahman, M. N. A., Ramli, R., & Azhari, C. H. (2011). Disassemblability of end-of-life vehicle: a critical review of evaluation methods. *Journal of Cleaner Production, 19*(13), 1536-1546. doi:http://dx.doi.org/10.1016/j.jclepro.2011.05.003

Goodland, R. (1995). The Concept of Environmental Sustainability. *Annual Review of Ecology and Systematics, 26*, 1-24. doi:10.2307/2097196

Goodland, R., & Daly, H. (1993). Why Northern income growth is not the solution to Southern poverty. *Ecological economics, 8*(2), 85-101. doi:http://dx.doi.org/10.1016/0921-8009(93)90038-8

Goodland, R., & Daly, H. (1996). Environmental Sustainability: Universal and Non-Negotiable. *Ecological Applications, Vol. 6*(4), 1002-1017.

Gramann H., Krapp R., & Bertram V. (2009). Disposal and Recycling of HSC materials. *Ship Science and Technology, 3*(5), 93-106.

Grants, E. (2006). Sustainable Development Policy and Guide for The EEA Financial Mechanism & The Norwegian Financial Mechanism: Adopted.

Greene, J. C., Caracelli, V. J., & Graham, W. F. (1989). Toward a Conceptual Framework for Mixed-Method Evaluation Designs. *Educational Evaluation and Policy Analysis, 11*(3), 255-274.

Grünbaum, N. N. (2007). Identification of ambiguity in the case study research typology: what is a unit of analysis? *Qualitative Market Research: an international journal, 10*(1), 78-97.

Guba, E. G., & Lincoln, Y. S. (1989). *Fourth generation evaluation*. Newbury Park, Calif. ; London: Sage.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of qualitative research, 2*(163-194), 105.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field methods, 18*(1), 59-82.

Hammersley, M. (2008). The SAGE handbook of social research methods. In P. Alasuutari, L. Bickman, & J. Brannen (Eds.). Los Angeles, Calif. ; London: SAGE.

Hart, M. (2010). Sustainability Indicators 101. Retrieved from http://www.sustainablemeasures.com/node/42

Hawkes, D. (2011). In brief: a history of sustainable architecture. Retrieved from http://www.architecture.com/SustainabilityHub/Designstrategies/Introduction/1-0-5-Inbriefahistoryofsustainablearchitecture.aspx

Hedlund-Åström, A., Luttropp, C., & Reinholdsson, P. (2005). *Environmental friendly recycling of FRP-sandwich ship hulls*.

HM Government. (2016). The Building regulations 2010. 2013 Edition incorporating 2016 amendments. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/540327/BR__PDF__AD_L1B_2013_with_2016_amendments.pdf
Hofstede, G. (1980). Motivation, leadership, and organization: Do American theories apply abroad? *Organizational dynamics, 9*(1), 42-63. doi:http://dx.doi.org/10.1016/0090-2616(80)90013-3
Hofstede, G. (1984). Cultural dimensions in management and planning. *Asia Pacific journal of management, 1*(2), 81-99. doi:10.1007/BF01733682
Hofstede, G. (2011). Dimensionalizing cultures: The Hofstede model in context. *Online readings in psychology and culture, 2*(1), 8.
Holt, M. (2009). *Nuclear Energy Policy* Retrieved from http://books.google.co.uk/books?hl=en&lr=&id=vmIxpcpJwHsC&oi=fnd&pg=PA1&dq=Closing+and+Decommissioning+Nuclear+Power+Reactors+-+UNEP&ots=VUQ91GmBoW&sig=QkkaNwA0_rwqOPT5eA7m-LahVc4 - v=onepage&q&f=false
Hotelling, H. (1931). The economics of exhaustible resources. *The journal of political economy*, 137-175.
Howarth, T., & Watson, P. D. (2009). *Construction safety management*. Oxford: Wiley-Blackwell.
Hueting, R., & Reijnders, L. (1998). Sustainability is an objective concept. *Ecological Economics, 27*(2), 139-148.
Idoro, G. (2004). *The effect of globalization on safety in the construction industry in Nigeria*. Paper presented at the Proceedings of International Symposium on Globalisation and Construction.
Idoro, G. I. (2008). Health and safety management efforts as correlates of performance in the Nigerian construction industry. *Journal of Civil Engineering and Management*, *14*(4), 277-285. doi:10.3846/1392-3730.2008.14.27
Inäcio, M. F. M. (1999). *THE BUILDING DECONSTRUCTION PROCESS*

AND THE DEBRIS TRAIL : TOWARDS A

DYNAMIC MODEL. (PhD), University of Salford.
Inäcio;, M. F. M. (1999). *THE BUILDING DECONSTRUCTION PROCESS*

AND THE DEBRIS TRAIL : TOWARDS A

DYNAMIC MODEL. (PhD), University of Salford.
International Atomic Energy Agency IAEA. (1999). Decommissioning of Nuclear Power Plants and Research Reactors SAFETY GUIDE *IAEA SAFETY STANDARDS SERIES No. WS-G-2.1*. Vienna.
International Atomic Energy Agency IAEA. (2006). *The Decommissioning Process*. Manila, Philippines. http://www-ns.iaea.org/downloads/rw/projects/r2d2/workshop1/lectures/L

ectures batandjieva-stoiber-lund/the-decommissioning-process.pdf
International Centre for Nigerian Law, I. (2016). Environmental Impact Assessment Decree No 86 of 1992 Laws of the Federation of Nigeria. Retrieved from http://www.nigeria-law.org/Environmental Impact Assessment Decree No. 86 1992.htm
Jang, Y.-C., & Kim, M. (2010). Management of used & end-of-life mobile phones in Korea: A review. *Resources, Conservation and Recycling, 55*(1), 11-19. doi:http://dx.doi.org/10.1016/j.resconrec.2010.07.003
Joint US/Russian Study Team. (1998). *Joint U.S./Russian Study on the Development of a Decommissioning Strategy Plan for RBMK-1OOOUnit #1 at the Leningrad Nuclear Power Plant.* Retrieved from
Kalejaiye, P. O. (2013). Occupational health and safety: Issues, challenges and compensation in Nigeria. *Peak: Journal of Public Health and Management, 1*(2), 16-23.
Keoleian, G. A., Kar, K., Manion, M. M., & Bulkley, J. W. (1997). *Industrial ecology of the automobile : a life cycle perspective*. Warrendale, Pa.: Society of Automotive Engineers.
Keraminiyage, K. P. (2009). *Achieving high process capability maturity in construction organisations.* PhD thesis, Built Environment., Salford.
Kibert, C. (1993). CONSTRUCTION MATERIALS FROM RECYCLED POLYMERS. *Proceedings of the ICE-Structures and Buildings, 99*(4), 455-464.
Kibert, C. (2005). *Sustainable construction : green building design and delivery*. Hoboken, N.J.: Wiley.
Kibert, C., Sendzimir, J., & Guy, B. (2000). Construction ecology and metabolism: natural system analogues for a sustainable built environment. *Construction Management & Economics, 18*(8), 903-916. doi:10.1080/014461900446867
Kibert, C. J. (2002). Policy instruments for a sustainable built environment. *Journal of Land Use & Environmental Law, 17*(2), 379-394.
Kim, V. (2013). Most creative ways to recycle a plane. *Business Traveller.* Retrieved from http://edition.cnn.com/2013/09/04/travel/recycled-planes/index.html
King, N. (1998). Template analysis.
King, N. (2012). Doing template analysis. *Qualitative organizational research: Core methods and current challenges*, 426-450.
Knight, W. A., & Sodhi, M. (2000). Design for Bulk Recycling: Analysis of Materials Separation. *CIRP Annals - Manufacturing Technology, 49*(1), 83-86. doi:http://dx.doi.org/10.1016/S0007-8506(07)62901-1
Koplin, J., Seuring, S., & Mesterharm, M. (2007). Incorporating sustainability into supply management in the automotive industry – the case of the Volkswagen AG. *Journal of Cleaner Production, 15*(11–12), 1053-1062. doi:http://dx.doi.org/10.1016/j.jclepro.2006.05.024

Koskela, L. (1992). *Application of the new production philosophy to construction*: Stanford University Stanford, CA.
Koskela, L. (2000). *An exploration towards a production theory and its application to construction.* VTT Technical Research Centre of Finland.
Koskela, L. J., & Kagioglou, M. (2007). The Proto-theory of Design: the method of analysis of the ancient geometers.
Ladan, M. T. (2012). Review of Nesrea Act 2007 and Regulations 2009-2011: A New Dawn in Environmental Compliance and Enforcement in Nigeria. *Law Env't & Dev. J., 8*, 116.
Latham, M. (1994). Constructing the Team: The Latham Report. Final Report of the Government/Industry Review of Procurement and Contractual Arrangements in the UK Construction Industry. *HMSO*.
Ledesma, E. F., Jiménez, J. R., Ayuso, J., Fernández, J. M., & de Brito, J. (2015). Maximum feasible use of recycled sand from construction and demolition waste for eco-mortar production – Part-I: ceramic masonry waste. *Journal of Cleaner Production, 87*, 692-706. doi:http://dx.doi.org/10.1016/j.jclepro.2014.10.084
Lee, A. (2002). *The development of a project process evaluation (PPE) framework that aims to measure the effectiveness of implementing a new design and construction project process.* (PhD), University of Salford, Salford, UK.
Leonard, A. (2010). *The story of stuff: How our obsession with stuff is trashing the planet, our communities, and our health-and a vision for change*: Simon and Schuster.
Leonard-Barton, D. (1990). A Dual Methodology for Case Studies: Synergistic Use of a Longitudinal Single Site with Replicated Multiple Sites. *Organization Science, 1*(3), 248-266. doi:doi:10.1287/orsc.1.3.248
Leung, M.-Y., & Olomolaiye, P. (2010). Construction stakeholder management. In E. Chinyio & P. O. Olomolaiye (Eds.). Oxford: Wiley-Blackwell.
Lim, S.-R., & Schoenung, J. M. (2010). Toxicity potentials from waste cellular phones, and a waste management policy integrating consumer, corporate, and government responsibilities. *Waste Management, 30*(8–9), 1653-1660. doi:http://dx.doi.org/10.1016/j.wasman.2010.04.005
Lingard, H., & Rowlinson, S. M. (2005). *Occupational health and safety in construction project management*. London: Spon.
LOPES, J. P. (1997). *Interdependence between the construction sector and the national economy in developing countries: a special focus on Angola and Mozambique.* (PhD), University of Salford. Retrieved from http://sal-primo-production.hosted.exlibrisgroup.com/primo_library/libweb/action/display.do?tabs=detailsTab&ct=display&fn=search&doc=44SAL_EPR_DS14680&indx=6&recIds=44SAL_EPR_DS14680&recIdxs=5&elementId=5&renderMode=poppedOut&displayMode=full&frbrVersion=2&dscnt=1&tab=all&dstmp=1382265723071&srt=rank&mode=Advanced&vl%281UIStartWith1%29=contains&tb=t&vl%28drStartYear5%29=Year&vl%2851409983UI5

%29=00&vl%28freeText0%29=construction%20economy&vid=SAL_MAIN&vl%28freeText2%29=&vl%2851409994UI3%29=all_items&vl%2851409985UI5%29=00&vl%2851409986UI5%29=Year&frbg=&vl%2851409988UI4%29=all_items&vl%28D51409991UI2%29=any&vl%281UIStartWith2%29=contains&dum=true&vl%2851409992UI0%29=any&vl%28D51409996UI1%29=any&vl%281UIStartWith0%29=contains&Submit=Search&vl%28freeText1%29=&vl%2851409984UI5%29=00&vl%2851409982UI5%29=00

Mark, D. (2000). Sustainability and sustainable development. In D. C. Dunphy (Ed.), *Sustainability : the corporate challenge of the 21st century*. St. Leonards, N.S.W. ; [London]: Allen & Unwin.

Maxwell, J. (1992). Understanding and validity in qualitative research. *Harvard educational review, 62*(3), 279-301.

Mayring, P. (2007). *On generalization in qualitatively oriented research.* Paper presented at the Forum Qualitative Sozialforschung/Forum: Qualitative Social Research.

Mayyas, A., Qattawi, A., Omar, M., & Shan, D. (2012). Design for sustainability in automotive industry: A comprehensive review. *Renewable and Sustainable Energy Reviews, 16*(4), 1845-1862. doi:http://dx.doi.org/10.1016/j.rser.2012.01.012

McDonough, W. (1992). *The Hannover Principles*

Design for Sustainability. Retrieved from Hannover Germany:

McDonough, W., & Braungart, M. (2009). *Cradle to cradle : remaking the way we make things*. London: Vintage.

Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W. (1972). *The limits to growth : A report for the Club of Rome's project on The Predicament of Mankind*. New York: A Potomac Associates Book.

Meadows, D. H., Randers, J., Meadows, D. L., & Meadows, D. H. B. t. l. (2004). *Limits to growth : the 30-year update* ([3rd rev., expanded and updated ed.] / Donella Meadows, Jorgen Randers and Dennis Meadows. ed.). London: Earthscan, 2005.

Merriam, S. B. (1988). *Case study research in education: A qualitative approach*: Jossey-Bass.

Milanovic, B., & Yitzhaki, S. (2002). Decomposing world income distribution: does the world have a middle class? *Review of Income and Wealth, 48*(2), 155-178.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*: Sage.

Mok, H. S., Kim, H. J., & Moon, K. S. (1997). Disassemblability of mechanical parts in automobile for recycling. *Computers & Industrial Engineering, 33*(3–4), 621-624. doi:http://dx.doi.org/10.1016/S0360-8352(97)00207-6

Moseley, W. G. (2001). African evidence on the relation of poverty, time preference and the environment. *Ecological economics, 38*(3), 317-326.

Museum of London. (2013). Join the Friends of the Museum of London. In M. o. London (Ed.). London: Museum of London.
Nabegu, A. B. (2008a). An assessment of Refuse Management and Sanitation Board (REMASAB) Solid waste management in Kano metropolis. *Techno–Science Africana Journal, 1*, 101-108.
Nabegu, A. B. (2008b). *Municipal Solid Waste Characteristics in three Residential Zones of Kano Metropolis: Implications for Management.* Paper presented at the Geography and the MillenniumDevelopment Goals: Translating Vision into Reality in Nigeria. Association Geographers Conference Book of proceedings, Calabar, Index Books Publishers Ltd.
Nabegu, A. B. (2010). An analysis of municipal solid waste in Kano metropolis, Nigeria. *Journal of Human Ecology, 31*(2), 111-119.
Nabegu, B. (2008c). *Municipal Solid Waste Characteristics in three Residential Zones of Kano Metropolis: Implications for Management.* Paper presented at the Geography and the MillenniumDevelopment Goals: Translating Vision into Reality in Nigeria. Association Geographers Conference Book of proceedings, Calabar, Index Books Publishers Ltd.
NAJAM, A. (2005). Developing Countries and Global Environmental Governance: From Contestation to Participation to Engagement. *International Environmental Agreements, 5*, 303-321. doi:10.1007/s10784-005-3807-6
Nardi, P. M. (2006). *Doing survey research : a guide to quantitative methods* (2nd ed. ed.). Boston, Mass. ; London: Pearson/Allyn and Bacon.
National Environmental Standards and Regulations Enforcement Agency, N. (2016). Laws and Regulations. Retrieved from http://www.nesrea.gov.ng/regulations/index.php
National Federation of Demolition Contractors, N. (2015). National Federation of Demolition Contractors. Retrieved from http://demolition-nfdc.com/page/about.html
National Institute of Building Sciences. (2012). Whole Building Design Guide. Retrieved from http://www.wbdg.org/
National Occupational Safety and Health Information Centre. (2006). *Nigeria: Report of the National Occupational Safety and Health Information Centre, .* Retrieved from Geneva, Switzerland: http://www.ilo.org/legacy/english/protection/safework/cis/about/mtg2006/pnga_mlpid.pdf
Nnorom, I. C., & Osibanjo, O. (2008). Electronic waste (e-waste): Material flows and management practices in Nigeria. *Waste Management, 28*(8), 1472-1479. doi:http://dx.doi.org/10.1016/j.wasman.2007.06.012
Nokia. (2013). Give your old phone a new life. Retrieved from http://www.nokia.com/global/about-nokia/people-and-planet/sustainable-devices/recycling/recycling/
Norgard, J. S., & Christensen, B. L. (1994). Technological Options and Sustainable Energy Welfare. In R. Samuels & D. K. Prasad (Eds.), *Global Warming and the Built Environment*. London: E & FN SPON.

Nowak, P. O., Steiner, M., & Wiegel, U. (2009). Waste Management Challenges for the Construction Industry. *Construction Information Quarterly*, *11*(1), 5-11.
Nuclear Energy Agency NEA. (2013, 22 October, 2013). International Co-operative Programme on Decommissioning (CPD). Retrieved from http://www.oecd-nea.org/jointproj/decom.html
Odum, E. P. (1977). *Fundamentals of ecology* (3rd ed. ed.). [S.l.]: W B Saunders Co.
Odum, E. P. (1983). *Basic ecology*. Philadelphia, [Pa.] ; London: Saunders College.
Odum, E. P. (1993). *Ecology and our endangered life-support systems* (2nd ed. ed.). Sunderland, Mass.: Sinauer Associates.
Ogunshakin, L., & Olayiwola, L. (1992). The collapse of official housing policy in Nigeria. *Habitat International*, *16*(1), 41-53. doi:http://dx.doi.org/10.1016/0197-3975(92)90006-K
Okafor, C. (2015, 02 June 2015). Nigeria-China Trade Volume Rises to $23.5bn. *This Day Live*. Retrieved from http://www.thisdaylive.com/articles/nigeria-china-trade-volume-rises-to-23-5bn/210947/
Olivetti, E. A., Gregory, J., & Kirchain, R. E. (2008). *Original equipment manufacturer end-of-life equipment collection metrics.* Paper presented at the Electronics and the Environment, 2008. ISEE 2008. IEEE International Symposium on.
Olukoju, A. (2004). Nigerian cities in historical perspective. *Nigerian Cities*, 11-46.
Ongondo, F. O., & Williams, I. D. (2011a). Greening academia: Use and disposal of mobile phones among university students. *Waste Management, 31*(7), 1617-1634. doi:http://dx.doi.org/10.1016/j.wasman.2011.01.031
Ongondo, F. O., & Williams, I. D. (2011b). Mobile phone collection, reuse and recycling in the UK. *Waste Management, 31*(6), 1307-1315. doi:http://dx.doi.org/10.1016/j.wasman.2011.01.032
Ongondo, F. O., Williams, I. D., & Cherrett, T. J. (2011). How are WEEE doing? A global review of the management of electrical and electronic wastes. *Waste Management*, *31*(4), 714-730. doi:http://dx.doi.org/10.1016/j.wasman.2010.10.023
Onyenechere, E. (2004). Water supply measures used by the rural people of Ebonyi and Enugu, Nigeria. *Journal of Water Supply: Research and Technology-Aqua, 53*(6), 425-431.
Osmani, M. (2012). Construction Waste Minimization in the UK: Current Pressures for Change and Approaches. *Procedia - Social and Behavioral Sciences*, *40*(0), 37-40. doi:http://dx.doi.org/10.1016/j.sbspro.2012.03.158
Oxford Dictionaries. (Ed.) (2014). Oxford University Press.
Oxford Dictionaries. (Ed.) (2016) Oxford Dictionaries Language Matters. Oxford University Press.
Oxford Dictionaries, L. m. (Ed.) (2015) Oxford Dictionaries Language matters.
Oyegoke, A. S. (2010). Construction stakeholder management. In E. Chinyio & P. O. Olomolaiye (Eds.). Oxford: Wiley-Blackwell.
Pacheco-Torgal, F., Tam, V., Labrincha, J., Ding, Y., & de Brito, J. (2013). *Handbook of recycled concrete and demolition waste*: Elsevier.

Paiano, A., Lagioia, G., & Cataldo, A. (2013). A critical analysis of the sustainability of mobile phone use. *Resources, Conservation and Recycling, 73*(0), 162-171. doi:http://dx.doi.org/10.1016/j.resconrec.2013.02.008
Park, H., Russell, C., & Lee, J. (2007). National culture and environmental sustainability: A cross-national analysis. *Journal of Economics and Finance, 31*(1), 104-121.
Patzer, G. L. (1996). *Experiment-research methodology in marketing : types and applications*. Westport, Conn. ; London: Quorum.
Pawlyn, M. (2011). *Biomimicry in architecture*. London: Riba Publishing.
PGT International Limited. (2016). PGT Reclaimed. Retrieved from http://www.pgt-reclaimed.com/
Phillips, D. A. (2003). *Nigeria*: Chelsea House.
Pimentel, D., Stachow, U., Takacs, D. A., Brubaker, H. W., Dumas, A. R., Meaney, J. J., . . . Corzilius, D. B. (1992). Conserving biological diversity in agricultural/forestry systems. *BioScience, 42*(5), 354-362.
Pinterest Ltd. (2016). Timber Furniture. Retrieved from https://www.pinterest.com/explore/timber-furniture/
Polák, M., & Drápalová, L. (2012). Estimation of end of life mobile phones generation: The case study of the Czech Republic. *Waste Management, 32*(8), 1583-1591. doi:http://dx.doi.org/10.1016/j.wasman.2012.03.028
Polis, G. A., & Strong, D. R. (1996). Food web complexity and community dynamics. *American Naturalist*, 813-846.
Rabiee, F. (2004). Focus-group interview and data analysis. *Proceedings of the Nutrition Society, 63*(04), 655-660. doi:doi:10.1079/PNS2004399
Raine, S. (2013). *China's African challenges* (Vol. 404): Routledge.
Randers, J. (2012). The Real Message of The Limits to Growth A Plea for Forward-Looking Global Policy. *GAIA-Ecological Perspectives for Science and Society, 21*(2), 102-105.
Rao, A., Jha, K. N., & Misra, S. (2007). Use of aggregates from recycled construction and demolition waste in concrete. *Resources, Conservation and Recycling, 50*(1), 71-81. doi:http://dx.doi.org/10.1016/j.resconrec.2006.05.010
RIBA, R. I. o. B. A. (2009a). Carbon Literacy Briefing. Retrieved 21/03/2013 http://www.architecture.com/Files/RIBAHoldings/PolicyAndInternationalRelations/Policy/Environment/2Carbon_Lit_Briefing.pdf
RIBA, R. I. o. B. A. (2009b). Climate Change Tool Kit 08: Whole Life

Assessment for Low Carbon Design. Retrieved 20/03/2013 http://www.architecture.com/Files/RIBAHoldings/PolicyAndInternationalRelations/Policy/Environment/WholeLifeAssessment.pdf
RIBA, R. I. o. B. A. (2009c). Low carbon standards and assessment methods. Retrieved 20/03/2013 http://www.architecture.com/Files/RIBAHoldings/PolicyAndInt

ernationalRelations/Policy/Environment/2Low_Carbon_SA_Methods.pdf
RIBA, R. I. o. B. A. (2009d). Principles of Low Carbon Design and Refurbishment. Retrieved 20/03/2013 http://www.architecture.com/Files/RIBAHoldings/PolicyAndInternationalRelations/Policy/Environment/2Principles_LC_Design_Refurb.pdf
Richardson, L. (1994). Writing. A method of inquiry. I NK Denzin & YS Lincoln (red): Handbook of qualitative research: Thousand Oaks: Sage.
Rogers, K. (2011). Two Years Under Glass:The First Biosphere 2 Mission. Retrieved from http://www.britannica.com/blogs/2011/09/years-glass-biosphere-2-mission/
Rotimi Williams. *OCCUPATIONAL SAFETY AND HEALTH PROTECTION OF THE NATIONAL LABOUR FORCE THE CONSTITUTIONAL AND LEGAL PERSPECTIVE* Speach.
Rotimi Williams. (ND). *OCCUPATIONAL SAFETY AND HEALTH PROTECTION OF THE NATIONAL LABOUR FORCE THE CONSTITUTIONAL AND LEGAL PERSPECTIVE*. PAPER PRESENTATION. Retrieved from http://docplayer.net/37682290-Occupational-safety-and-health-protection-of-the-national-labour-force-the-constitutional-and-legal-perspective-chief-rotimi-williams-cfr-san.html
Royal Commission on Environmental Pollution. (1985). *Managing Waste: The Duty of Care*. Retrieved from London:
Sanvido, V. E., & Medeiros, D. J. (1990). Applying computer-integrated manufacturing concepts to construction. *Journal of Construction Engineering and Management, 116*(2), 365-379.
Saphores, J.-D. M., Ogunseitan, O. A., & Shapiro, A. A. (2012). Willingness to engage in a pro-environmental behavior: An analysis of e-waste recycling based on a national survey of U.S. households. *Resources, Conservation and Recycling, 60*(0), 49-63. doi:http://dx.doi.org/10.1016/j.resconrec.2011.12.003
Sassi, P. (2008). Defining closed-loop material cycle construction. *Building Research & Information, 36*(5), 509-519. doi:10.1080/09613210801994208
Saunders, M., Lewis, P., & Thornhill, A. (2012). *Research methods for business students* (6th ed. ed.). Harlow, England ; New York: Pearson.
Scharnhorst, W., Althaus, H.-J., Classen, M., Jolliet, O., & Hilty, L. M. (2005). The end of life treatment of second generation mobile phone networks: Strategies to reduce the environmental impact. *Environmental Impact Assessment Review, 25*(5), 540-566. doi:http://dx.doi.org/10.1016/j.eiar.2005.04.005
Schneider, D., & Ragossnig, A. (2014). Impacts and limitations of recycling. *Waste Management & Research, 32*(7), 563-564. doi:10.1177/0734242x14541620
Schwerdtfeger, F. W. (1982). *Traditional Housing in African Cities: A Comparative Study of Houses in Zaria, Ibadan, and Marrakech*: LUP.

Sen, A. (1989). Cooperation, Inequality, and the Family. *Population and Development Review*, *15*, 61-76. doi:10.2307/2807922

Sendzimir, J., & Guy, G. B. (Eds.). (2001). *Construction ecology: nature as the basis for green buildings*. GB: Spon (E&F).

Sha'Ato, R., Aboho, S. Y., Oketunde, F. O., Eneji, I. S., Unazi, G., & Agwa, S. (2007). Survey of solid waste generation and composition in a rapidly growing urban area in Central Nigeria. *Waste Management, 27*(3), 352-358. doi:http://dx.doi.org/10.1016/j.wasman.2006.02.008

Shah, A. (2011). Consumption and Consumerism. *Global Issues.* Retrieved from <http://www.globalissues.org/issue/235/consumption-and-consumerism>.

Shell Livewire UK. (2013). Elements of Sustainable Development: Environment, Society and Economy. Retrieved from http://www.shell-livewire.org/business-library/employing-people/management/sustainable-development/Sustainable-development

Skoyles, E. R., & Skoyles, J. R. (1987). *Waste prevention on site*: BT Batsford Limited.

Solís, J. L. F. (2009). How the Construction Industry does differ from manufacturing? Retrieved from http://ascpro0.ascweb.org/archives/cd/2009/paper/CERT136002009.pdf

Suddaby, R. (2006, 08//). FROM THE EDITORS: WHAT GROUNDED THEORY IS NOT, Editorial. *Academy of Management Journal*, pp. 633-642. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&AuthType=shib,cookie,ip,url,uid&db=buh&AN=22083020&custid=s2888710

Sullivan, L. (2012). <RIBAGuidetoSustainabilityinPractice.pdf>.

Tahvonen, O. (2000). Economic Sustainability and Scarcity of Natural Resources: A Brief Historical Review.

The American Heritage. (Ed.) (2013) economics. (n.d.) (Fourth Edition ed.). The American Heritage®.

The Economist, I. U. (2014). Falling Poverty and Rising Income Inequality in Nigeria. *The Economist Intelligence Unit*. Retrieved from http://country.eiu.com/article.aspx?articleid=1432272327&Country=Nigeria&topic=Politics

Thomas, D. H. L., & Adams, W. M. (1997). Space, Time and Sustainability in the Hadejia-Jama'Are Wetlands and the Komodugu Yobe Basin, Nigeria. *Transactions of the Institute of British Geographers, 22*(4), 430-449. doi:10.2307/623111

Thompson, R. W. (2012). Three Amazing Airplane Hotels. Retrieved from http://www.apartmenttherapy.com/three-amazing-airplane-hotels-174207

Tietenberg, T. H. (2007). *Environmental economics and policy* (5th ed. ed.). Boston, Mass. ; Harlow: Pearson/Addison-Wesley.
Todaro, M. P., & Smith, S. C. (2011). *Economic development* (11th ed. ed.). Harlow: Addison Wesley.
Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection.
Turteltaub, J. (Producer). (1999). Instinct (Movie).
U.S. Green Building Council. (2002). *BUILDING MOMENTUM*

National Trends and Prospects for High-Performance

Green Buildings. Retrieved from Baltimore, Maryland:
UK Green Building Council. (2013). Key Statistics. Retrieved from http://www.ukgbc.org/content/key-statistics-0
UNDP. (1998). *HUMAN*

DEVELOPMENT

REPORT 1998. Retrieved from http://www.undp.org/undp/hdro
UNDP. (2013).

The Millennium Development Goals: Eight Goals for 2015. Retrieved from http://www.undp.org/content/undp/en/home/mdgoverview.html
UNEP, U. N. E. P. (2012). *Emrerging Issues in our Global Environnment* Retrieved from Nairobi: http://www.unep.org/yearbook/2012/pdfs/UYB_2012_FULLREPORT.pdf
United Nations Environment Programme, U. N. E. P. (2013). *Guidelines for National Waste Management Strategies: Moving from Challenges to Opportunities*. Retrieved from http://www.unep.org/ietc/Portals/136/Publications/Waste Management/UNEP NWMS English.pdf.
Urquhart, A. W. (1977). *Planned Urban Landscapes of Northern Nigeria : a case study of Zaria*. Zaria: Ahmadu Bello University Press.
van Heerden, D.-J., & Curran, R. (2011). Value extraction from end-of-life aircraft. *Encyclopedia of Aerospace Engineering. Wiley*.
Van Maanen, J., SØRensen, J. B., & Mitchell, T. R. (2007). THE INTERPLAY BETWEEN THEORY AND METHOD. *Academy of Management Review, 32*(4), 1145-1154. doi:10.5465/AMR.2007.26586080
Velis, C. A., Wilson, D. C., Rocca, O., Smith, S. R., Mavropoulos, A., & Cheeseman, C. R. (2012). An analytical framework and tool (‘InteRa’) for integrating the informal recycling sector in waste and resource management systems in developing countries. *Waste Management & Research, 30*(9 suppl), 43-66.
Wahab, A., & Lawal, A. (2011). An evaluation of waste control measures in construction industry in Nigeria. *African Journal of Environmental Science and Technology, 5*(3), 246-254.

Watson, T. J. (2011). Ethnography, reality, and truth: the vital need for studies of ‘how things work’in organizations and management. *Journal of Management Studies, 48*(1), 202-217.
Weeks, G. (2013). Amazing pictures of aeroplane turned hotel. *Lifestyle*.
Weeks III, J. A. (2009). Field Guide To Aircraft Boneyards. Retrieved from http://www.johnweeks.com/boneyard/
Whitsitt, N. (2003). Islamic-Hausa Feminism Meets Northern Nigerian Romance: The Cautious Rebellion of Bilkisu Funtuwa. *African Studies Review, 46*(1), 137-153. doi:10.2307/1514984
Wiersma, W. (1985). *Research methods in education: An introduction*.
Wilcox, W., Horvath, P. A., Griffis, S. E., & Autry, C. W. (2011). A Markov model of liquidity effects in reverse logistics processes: The effects of random volume and passage. *International Journal of Production Economics, 129*(1), 86-101. doi:http://dx.doi.org/10.1016/j.ijpe.2010.09.005
Williams, I. D. (2015). Forty years of the waste hierarchy. *Waste Management, 40*, 1-2. doi:http://dx.doi.org/10.1016/j.wasman.2015.03.014
Williams, R. (2010). A CRITIQUE OF THE FACTORIES ACT IN LIGHT OF

CHANGING WORK PATTERNS AND OCCUPATIONAL SAFETY

AND HEALTH PRACTICE. *Labour Law Review, NJLIR VOL. 4 N0. 1, 2010.*
World Bank. (2011). *Nigeria - Growth and Employment in States Project.* (54457). Retrieved from Washington, DC: http://documents.worldbank.org/curated/en/2011/02/13973259/nigeria-growth-employment-states-project
Xie, S., Qi, L., & Zhou, D. (2004). Investigation of the effects of acid rain on the deterioration of cement concrete using accelerated tests established in laboratory. *Atmospheric Environment, 38*(27), 4457-4466. doi:http://dx.doi.org/10.1016/j.atmosenv.2004.05.017
Yin, R. K. (1981). The Case Study Crisis: Some Answers. *Administrative Science Quarterly, 26*(1), 58-65. doi:10.2307/2392599
Yin, R. K. (1994). *Case study research : design and methods*. Thousand Oaks, Calif. ; London

London: Thousand Oaks, Calif. ; London : Sage.
Yin, R. K. (2009). *Case study research : design and methods* (4th ed. ed.). London: SAGE.
Zarei, M., Mansour, S., Hosseinzadeh Kashan, A., & Karimi, B. (2010). Designing a Reverse Logistics Network for End-of-Life Vehicles Recovery. *Mathematical problems in engineering, 2010*(6), 1-17.
Zero Carbon Hub. (2013). *Zero Carbon Strategies for Tomorrow’s New Home* Retrieved from http://www.zerocarbonhub.org/resourcefiles/ZeroCarbonStrategies_web.pdf

Appendices

Appendix 1

Research Participant Invitation/Information Sheet

Research Title

Building Decommissioning Process for Sustainable Waste Management - using the "Ethnomimicry" of the Nigerian Industrial Ecology.

Invitation to participate

………………………………………………………………………………………

This is to invite you to participate in a research study of the above title. You are advised to take time to understand the purpose of the research and the demands of your expected role. The information you need to decide whether or not to participate is provided on this document. Notwithstanding, you are free to ask questions on any aspect or terminology.

Purpose of the study

The purpose of this study is to develop a sustainable waste management process for decommissioning of buildings using inspirations of the interactions of the various stakeholders involved in the process of building decommissioning in Nigeria.

Why you are invited to participate

You have been selected to participate in this research study based on information and the confirmation received from you that you were at least once or several times directly involved in the process of building demolition or handling of the bye-products of building demolition in any capacity. You are therefore recognised as "information laden" personality whose contribution to this study is considered very important.

Acceptance to participate

Participation in this study is voluntary; if you willingly decided to participate, the study will be described to you and thereafter you may be requested to sign a consent form to show that you agreed to participate in this study. You are free to withdraw at any time, without giving any reason and without any effect on your relationship with your employer, the researcher, or your professional or business interest.

What happens if you accept to participate

Upon your acceptance to participate, you will be required to grant an in-depth interview whereby you will respond to relevant questions from the researcher. The interview may last between one to three hours at a time and venue convenient to you and considered safe for the interviewer and the interviewee.

Reward for participation

Your participation in this study will be highly appreciated; nonetheless, while you are not expected to incur any expenses towards this study, there will be no any material reward in cash or in kind for your participation.

Disadvantages and risks for participation

There may be inconveniences and discomfort associated with lengthy interviews for some individuals. Moreover, some questions may be sensitive to some critical issues related to the career of a participant. Otherwise, there is no any foreseen negative effect for participating in this study.

Possible benefits for participation

There are no any intended benefits for the participants but information obtained from the study will help to increase the understanding of the process of sustainable demolition waste management as it is practiced in Nigeria.

Complaints and dissatisfaction

For any concern about any aspect of this study, the researcher will do his best to respond to your inquiry, however, if you remain dissatisfied a formal complaint can be lodge through Annette Cooke of the University Governance Services Unit (GSU) on +44 161 295 4123 or by email to gov-studentcomplaints@salford.ac.uk, .

Confidentiality

The interview will be audio recorded and thereafter transcribed into text by the researcher for the purpose of analysis. The text will be presented to you for confirmation and verification as a follow up to the interview. However, at no any time or medium will any material from the interview be identified with you as a person without your consent.

Hard and soft copy of individual research data will be anonymous and given a research code only known and accessible to the researcher who will only use it for the purpose of this study.

Withdrawal from the study

You may decide to withdraw from the study at any time and the data collected up to the time of your withdrawal will only be used with your permission, otherwise, it will be destroyed.

Results of the research study

The results of this study will be used in writing PhD thesis report and publications in academic journals. Participants will not be identified in such reports and publications without their permission.

Research organisation and sponsorship

This research is organised by the School of the Built Environment University of Salford UK and is sponsored by the Nigerian Tertiary Education Trust Fund (TETFUND).

About the researcher

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Information Sheet based on: COREC/NHS National Patient Safety Agency. *Information Sheets and Consent Forms – Guidance for Researcher and Reviewers'* Version 3.0 Dec 2006. Obtained from the University of Salford website: www.salford.ac.uk.

The questions' guide

A participant is expected to provide answers to questions on the topics listed below as detailed as possible from his/her first-hand experience on a project involving building demolition and/or handling of salvaged buildings materials.

Section 1: Background

Name (optional)**:**…………………………………………… **Occupation:**………..………….

Sector:……………………………….…………………………..**Experience** (years)**:**………

Decommissioning projects participated:……….**Status on project:**…………….……….

Salvaged materials handled :………………………………….……………………......

…………………………………………………………………………………………....

Section 2: General

Q0a. Can you give an account of any demolition project(s) you take part including events before, during and after the physical demolition?

Section 3: Thematic Questions

Theme 1:

Q1a. How are materials sorted after demolishing of buildings?

Q1b. How are materials for reuse identified from the materials for other purposes?

Q1c. What special consideration is given to materials that may hazardous?

Q1d. In what ways do you think designers of buildings consider ease of materials disassembly when the building may need to be decommissioned?

Q1e. Can you give information about the existence of materials database that may be helpful in sorting materials when buildings are decommissioned?

Q1f. What are the reasons that you think may prompt property owners to withdraw buildings from services?

Q1g. Can you describe the processes of transferring the ownership of salvaged building materials from the original owners to the would-be users?

Theme 2:

Q2a. What are the other creative applications that you know salvaged materials from demolished buildings may be in use?

Q2b. What role original building materials manufacturers play when buildings are demolished?

Q2c. What do you think is the correlation between buildings demolition and the performance of the national economy?

Q2d. Do you think it is feasible for buildings and building materials withdrawn from service to be recalled back for the same service?

Q2e. What is the private and public sectors' roles in the accreditation of demolition specialists?

Theme 3:

Q3a. What are the prescribed standard(s) for management of materials when buildings are demolished?

Q3b. In what circumstances building owners are required to install and maintain materials property labels?

Q3c. Are there products that you think pose special challenges for re-marketing at the end of its service in a building?

Q3d. What materials property database that may be useful while dismantling buildings?

Theme 4:

Q4a. What are the legislations guiding building demolition and salvaged materials management?

Q4b. What are the incentives for going into the profession(s) of salvaged building materials products?

Q4c. What are the different professions involved with buildings demolition and salvaged building materials products?

Q4d. How do you think dealers in salvaged building materials acquire the products?

Q4e. How likely are the building owners to dispose of the materials immediate after demolition?

Theme 5:

Q5a. In what ways do you think the lifespan of a building is determined?

Q5b. Can you describe your experience on working with buildings decommissioning plan?

Q5c. How do you think building approval processes affect demolition and your trade?

Q5d. Can you describe the processes involved in building decommissioning from your experience?

Q5e. From your experience, how do you think building decommissioning is financed?

Q5d. Who do you think are the beneficiaries of building decommissioning?

Theme 6:

Q6a. Can you identify the different categories of stakeholders in building demolishing?

Q6b. What materials from building demolishing are usually taken to the landfill?

Q6c. What are the steps involved in demolition buildings from start to finish?

Q6d. Can you identify the parties that usually purchase materials from demolished buildings?

Q6e. In what ways the materials from building demolishing are utilized?

Q6f. Can you describe the interaction between different stakeholders that participate in building decommissioning?

Theme 7:

Q7a. What are the considerations given to occupational health and safety in the process of building demolishing?

Q7b. Can you describe the legislations on occupational health and safety in the process of demolition?

Q7c. How are accidents victims treated in the process of building demolition?

Q7d. What do you think is the general attitude to records and statistics of accidents in building demolition?

Research Participant Consent Form

Research Title: *Building Decommissioning Process for Sustainable Waste Management – using the "Ethnomimicry" of the Nigerian Industrial Ecology.*

Ethics Ref No:

Name of Researcher: Aminu Lawan Abdullahi

(Tick ✓ as appropriate)

➢ I confirm that I have read and understood the information sheet for the above study (version x- date) and what my

Yes	

contribution will be.

➢ I have been given the opportunity to ask questions (face to face, via telephone and e-mail)	**Yes**	
➢ I agree to take part in the interview	**Yes**	
➢ agree to the interview being tape recorded	**Yes**	
➢ I agree to digital images being taken during the research exercises	**Yes**	
➢ I understand that my participation is voluntary and that I can withdraw from the research at any time **without giving any reason**	**Yes**	
➢ I understand how the researcher will use my responses, who will see them and how the data will be stored.	**Yes**	
➢ **I agree to take part in the above study**	**Yes**	

Name of participant ……………………………………………………………………………

Signature ……………………………………………………………………………….

Date ……………………………….

Name of researcher taking consent Aminu Lawan Abdullahi ……………………..……………………………………………

Researcher's e-mail address a.l.abdullahi@edu.salford.ac.uk, ratelplus@yahoo.co.uk ………………………………………………………………

Appendix 2

Takardar Bayanai da Gayyatar Taka-Rawa a Harkar Bincike.

Taken Bincike

“Kwaikayon-kabilu” Wajen Dangantakar Masana’antu a Nijeriya: Domin Samar da Dabarun Aiwatar da Rusau in Gine-gine da Ingantacciyar Hanyar Sarrafa Kayan-gwangwan.

Gayyatar shiga shirin bincike

……………………………………………………………………………………

Ana gayyatar ka domin taka-rawa a binciken-fasaha mai take kamar yadda aka bayyana a sama. Ana shawartar ka da yin nazarin dalilan yin wannan bincike da kuma muhimmancin rawar da za ka taka. Duk bayanan da ake bukata domin amincewa ko rashin amincewa a ba da gudunmawa ga wannan bincike suna nan tattare a wannan takarda. Bayan haka, ka na da damar yin tambaya ga duk wani abu da ya shige duhu.

Dalilan yin bincike

Ana gudanar da wannan bincike ne domin samar da tsarin ingantacciyar hanyar sarrafa kayan gwangwan a lokacin yin rusau ta hanyar nazarin dangantakar sana’oi da masu hannu a harkar rusau in gine-gine a Nijeriya.

Dalilin gayyatar ka domin ba da gudun mawa

An gayyace ka ne ka ba da gudun mawa a wannan bincike sakamakon samun tabbaccen kasancewa ka taba yin hulda da aikin rusau ko sarrafa kayan gwangwan da aka samar daga rusau. Domin haka ka kasance “masani” wanda gudunmawar ka take da matukar muhimmanci.

Amincewa da ba da Gudunmawa

Ba da gudunmawa ga wannan bincike aikin sa kai ne kurum; idan ka yarda ka shiga shirin, za a yi ma ka cikakken bayani akan wannan bincike. Sannan za a nemi ka sa hannu cewa da amincewar ka ka shiga. Sannan ka na da damar fita daga wannan shiri a duk lokacin da ka so ba tare da an tambaye ka hujja ba. Sannan fitar ka daga shirin ba zai shafi dangantakar ka ta aiki ko sana’a ba.

Abin da Zai Biyo Baya in Ka Amince.

Sa’ad da ka amince ka shiga shirin ba da gudunmawa, za a bukaci yin hira mai zurfi da kai, ya yin da za’a nemi ka yi jawabi kan wasu tambayoyi daga mai bincike. Wannan hira za ta dauki tsawon lokaci daga awa daya zuwa biyu. Sannan kai za ka zabi lokaci da amintaccen wajen da za a gudanar da wannan hira.

Sakayya domin ba da gudunmawa

Ba da gudunmawa ga wannan bincike na da matukar muhimmanci da amfani. Sai dai ba bu wani tanadi na ba da hasafi ga ma su ba da gudunmawa.

Illoli ko Hadarorin da ke Tattare da ba da Gudunmawa

A iya tantancewar zahiri, babu wata sananniyar illa ko hadari domin ba da gudunmawa ga wannan bincike. Sai dai takura da matsi da ka iya samuwa sakamakon doguwar hira da wasu tambayoyin kikkira da suka shafi sana’a.

Amfanin ba da Gudunmawa

Muhimmancin wannan bincike shine karin samun sani game da ingantattun hanyoyin sarrafa kayan gwangwan a Nijeriya. Bayan haka babu wata karuwa ta kebence da ta shafi masu ba da gudunmawa kurum.

Korafi da koke-koke

Idan da akwai wani korafi ko rashin gamsuwa game da wannan bincike, mai gudanar da binciken zai yi kokarin share hawaye. Za a aiya tuntubar mai binciken ta hanyoyin da aka bayyana a bangaren Game da Mai Bincike na wannan takarda.

Sirri

Za'a dauki hirar da aka yi da na'ura, sannan daga baya a rubuta a takarda domin tantancewa. Za a nuna maka rubutacciyar hirar domin ba da tabbacen ka. Amman ba inda za'a kama sunan ka ba tare da izinin ka ba. Sannan za'a yi amfani da lambobin sirri ne wajen aiki da bayanan da aka tara ba tare da kiran sunan kowa ba. Sannan ba za'a yi amfani da bayanan da aka tara ta wata hanya dabam ba.

Fita daga cikin shirin

Ka na da dama ka fita daga wannan shiri a duk lokacin da ka so, sannan sai da izinin ka za a yi amfani da bayanan da aka tara har zuwa lokacin fitar ka.

Sakamakon Bincike

Sakamakon wannan bincike za'a yi amfani da shi ne wajen rubutun kundin digri na uku a jami'a da mujallun ilimi na bincike-bincike. Amman ba za'a kama sunan masu ba da gudunmawa ba.

Shirya Bincike da Daukar Nauyi

An shirya wannan bincike ne a bangaren Kirkire-kirkire da zayyayane-zaayyane na Jami'ar Huddersfield da ke Ingila. (School of Art, Design, and Architecture University of Huddersfield UK) sannan hukumar asusun ba da tallafi na manyan makarantu ta kasa (TETFUND) ce ta dauki nauyi.

Game da Mai Bincike

Suna: Aminu Lawan Abdullahi

Adreshi: Bangaren zayyane-zayyane dake jami'ar kimiyya da fasaha ta Kano da ke Wudil.

C/O

School of Art, Design, and Architecture,

University of Hudderfield, UK

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Jadawalin Tambayoyi

A na bukatar mai ba da jawabi ya yi bayani mai zurfi akan tambayoyi na kasa kamar yadda ya sani daga tafiyar da sana'ar sa da ta shafi rusau da gwangwan.

Sashe na 1: Shinfida

Suna (ba dole)**:**………………………………………… **Sana'a:**……..………….

Bangare:……………………………..………………….**Shekarun sana'a:**………

Ayyukan rusau da aka yi da kai::…………………………………………………….

…………………………………………………………………………………………

……………………………………………………………………………………….…

Matsayi a aiki:…………………………………………..…………….………

Kayan gwangwan da aka sarrafa:…………………………..…………………......

……………………………………………………………………………………....

Sashe na 2: Tambayoyi

T1. Za ka iya ba da labari kan wani aiki ko ayyukan rusau da aka yi da kai tare da jawabin abubuwan da suka faru kafin, yayin, da bayan aiwatar da rusau in?

T2. Yaya ake gudanar da aikin rusau a Nijeriya, daki-daki?

T3. Su waye ke da hannu a aiwatar da rusau a Nijeriya?

T4. Yaya dangantakar ma su hannu a aiwatar da rusau a Nijeriya take?

T5. Wadanna kalubale harkar tafiyar da rusau a Nijeriya ke fuskanta?

T6. Wadanna hanyoyi ne za'a iya inganta harkar rusau a Nijeriya?

T7. Ta yaya hanyoyin tafiyar da rusau a Nijeriya su ka samo asali?

T8. Dame-dame ke iya shafar harkar tafiyar da rusau a Nijeriya?

T9. Wacce rawa matakan kiyaye lafiya da rage hadarukka ke takawa a harkar rusau a Nijeriya?

Takardar ba da Izinin Tattara Bayanai

Research Title: *The "Ethnomimicry" of the Nigerian Industrial Ecology: Development of Building Decommissioning Process for Sustainable Waste Management.*
Ethics Ref No: mdlu/2014/001/a

Sunan mai bincike: Aminu Lawan Abdullahi *(A yi tik ✓ inda ya dace)*

➢ Na tabbatar da na karanta kuma na fahimci jawabin bayanai na yin wannan bincike da kuma irin gudunmawar da zan bayar.	I	
➢ An ba ni damar yin tambayoyi (da baki, waya da e-mail)	I	
➢ Na amince ayi hira da ni	I	
➢ Na amince a nadi hira da na'ura	I	
➢ Na amice a dauki hotuna	I	
➢ Na fahimci gudunmawa ta aikin sa kai ne kurum, sannan ina iya fita daga Shirin wannan bincike a duk lokacin da na ga dama **ba tare da ba da wata hujja ba**	I	
➢ Na fahimci yadda mai bincike zai yi amfani da bayanai , da kuma wa zai ga bayanan, da kuma ta yadda za'a adana bayanan.	I	
➢ **Na amince in kasance cikin shirin wannan bincike**	I	

Sunan mai ba da ....

gudunmawa

Sa hannu ....

Kwanan wata ....

Aminu Lawan Abdullahi

Sunan mai bincike ....

ratel_plus@yahoo.com, ratelplus@yahoo.co.uk

Adreshin email na mai bincike ....