A decision-making framework for the sustainable redevelopment of abandoned public buildings in Nigeria.

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A DECISION-MAKING FRAMEWORK FOR THE SUSTAINABLE REDEVELOPMENT OF ABANDONED PUBLIC BUILDINGS IN NIGERIA.

BY

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ABSTRACT

The aim of this thesis is to examine the sustainability of infrastructure in Nigeria in line with the arrays of abandoned projects and recommend a sustainable solution to enhance their redevelopment. Hence, in contrast to previous studies, a model was developed to improve the decision-making process by the policymakers within the government.

The research investigates the causes of abandoned infrastructure in Nigeria and sustainable solutions for redevelopment through actions of literature review, questionnaire surveys and semi-structured interview. A sequential explanatory mixed method approach integrating the technique for order preference by similarity to an ideal solution (TOPSIS) technique was employed to identify the optimum ideal solution in addressing this abandonment. In addition, a decision-making model was developed with the five sustainability attributes (social, economic, environment, political, and technical - SEEPT), four alternatives (refurbishment, conversion, demolition and procurement) and ten criteria (project preparation and coordination, social sustainability, energy efficient, waste generation, preservation of historical value, investment, profitability, structural integrity and foundation, government regulations and policies, and carbon dioxide emission) as a support to enhance the decision-making process.

Underpinned with mathematical calculations and formulas, the validated model presented the flexible identification of the optimum solution (as *refurbishment*) during the decision-making process. The evaluation of alternatives against criteria and attributes represented a dynamic decision-making system. Moreso, further identification of political and technological sustainability presented a novel sustainability consideration within the study. Lastly, the need for innovative tools presented the opportunity for the development of the model and the eventual selection of refurbishment through the application of the model by the participants. This research argued that the integration of this model enhances the identification of possible solutions of addressing abandoned infrastructure in Nigeria. It also maintains that appropriate model configuration can stimulate appropriate decision-making processes.

The TOPSIS Model (TOPMod) developed in this research with embedded mathematical calculations and formulae presents an innovative approach for addressing decision making of abandoned infrastructure redevelopment. The 5Rs concepts present a qualitative approach to addressing the wastage of abandonment.

Keywords: Abandoned infrastructure, MCDM, Model, Nigeria, Public buildings**,** Sustainable development, TOPSIS, Redevelopment, Refurbishment, Waste Management.

DEDICATION

I dedicate this thesis to Almighty God for enabling the successful completion of my PhD journey. My Lord Jesus Christ, you called me out upon the waters, the great unknown where feet may fail. And there I find you in the mystery, in oceans deep, and my faith stands. I kept my eyes above the waves when oceans rise. My soul rest in your embrace for I am yours and you are mine. Your sovereign hands were my guide. My trust in you was without borders and you make me walk upon the waters, you take me deeper than my feet could ever wander, and my faith became stronger in the presence of you my Saviour, my Lord Jesus Christ.

Inspired by "Ocean (Where feet may Fail)"– A song by Hillsong United

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Omotayo, T., Awuzie, B., Egbelakin, T., Obi, L., Ogunnusi, M. (**2020**) 'AHP-systems thinking analyses for kaizen costing implementation in the construction industry', *Buildings*, 10(12), pp. 1–24. doi: 10.3390/buildings10120230.

Ogunnusi, M., Salman, H. and Laing, R. (**2021**) 'Infrastructure Development and Abandonment-Nigerian Context', The 11th International Structural and Engineering and Construction Conference (ISEC 11), July 2021.

Hamma-Adama, M., Ogunnusi, M., Mashwama, N.X., Ahmad, ABS., Abba, HA., (**202**1) 'Assessment of Risk Associated with Road Infrastructure Development in the Developing Countries' Global Scientific Journal 9 (7), 1223 – 1229.

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Ogunnusi, M., Salman, H. and Laing, R. (**2023**) 'TOPSIS analysis for sustainable redevelopment potential of abandoned infrastructure in Nigeria', Built environment project and asset management 13 (1), 73-88

Ogunmakinde, O.E., Egbelakin, T., Sher, W., Omotayo, T., Ogunnusi, M. (**2023**) 'Establishing the limitations of sustainable construction in developing countries: a systematic literature review using PRISMA', Smart and Sustainable Built Environment. DOI 10.1108/SASBE-10-2022-0223

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LIST OF ABBREVIATIONS

AEC	Architecture, Engineering, and Construction
AHP	Analytical Hierarchical Process
ANFIS	Adaptive Neuro-Fuzzy Inference System
ATA	All of the above
BIM	Building Information Modelling
BIM-DAS	BIM-based Deconstructability Assessment Score
BREEAM	Building Research Establishment Environmental Assessment Method
BS	Barometer of Sustainability
CO_2	Carbon dioxide
COVID-19	Corona Virus 2019
CPM	Changing procurement methods.
CSM	Constitute Social Menace
DDM	Designing with deconstructability in mind.
DMM	Decision Making Model
ELECTRE	Elimination and Choice Translating Reality
EU	European Union
FIDIC	The International Federation of Consulting Engineers
GDP	Gross Domestic Products
GT	Grounded Theory
Green BIM	Green Building Information Modelling
GUI	Graphical User Interface
HDI	Human Development Index
JCT	Joint Contracts Tribunal
LEED	Leadership in Energy and Environmental Design
MAUT	Multi Attribute Utility Theory
MCDA	Multi criteria Decision Analysis
MCDM	Multi Criteria Decision Making Method
NE	Non-eco-friendly
NEC	New Engineering Contract
NIS	Negative Ideal Solution
NSDI	National Sustainable Development Index
OECD	Organisation for Economic Cooperation and Development
PIS	Positive Ideal Solution
PROMETHEE	Preference Ranking Organisation METHod for Enriching of Evaluations
RAP	Refurbishment of abandoned projects
SAFE	Sustainability Assessment by Fuzzy Evaluation
SD	System Dynamics
SDGs	Sustainable Development Goals
SMEs	Small and medium-sized enterprises
SPSS	Statistical Package for the Social Sciences
SSI	Sustainability Society Index
TBL	Triple Bottom Line
TOPSIS	The Technique for Order Preference by Similarity to an Ideal Solution
UCLA	University of California, Los Angeles
UE	Uneconomical
UIMT	Using an innovative management tool
UNCTAD	United Nations on Trade and Development
UN DESA	United Nations Department of Economic and Social Affairs
UN	United Nations

VFM	Value for Money
WUR	Waste of useful resources

GLOSSARY OF TERMS

Abandoned	-Abandoned in the context of this research includes existing structures that were initially occupied for a certain period (more than one year) as defined by Ariffin et al. (2018) and Ekele et al. (2022), and subsequently vacated with no indication of when to resume utilisation.
Infrastructure	-Scheme of public mechanism in a nation, region, or state, including utility lines, roads, and public buildings.
Green BIM (gBIM)	- system of design and delivery of construction projects based on merging of BIM and sustainable building (Gandhi and Jupp, 2013; Araszkiewicz, 2016; Camarinha, 2016)
MCDM	- A sophisticated decision-making tool relating to both qualitative and quantitative components (see also List of Abbreviations).
GUI	Graphical User interface is an operating system, graphic-based interface that utilises menus, icons for effective management of interaction with the system. Four components of GUI environments include consistent applications, graphics library, user guide and interface toolkit.
Refurbishment	-Refurbishment is the process of improving buildings with the intention of ensuring the energy efficiency

CHAPTER ONE: INTRODUCTION AND BACKGROUND

1.0 INTRODUCTION

According to Weijnen et al. (2021 p.18);

> "*Historical civilisations cleverly took advantage of the natural infrastructure of mountain passes, waterways and other vantage points when choosing places for settlement"*.

Infrastructure as a term has then progressively modified from the focus on natural infrastructure to amenities and works of public interest (Weijnen et al. 2021).

The wealth and well-being of a nation is contingent on operable and readily available infrastructure (Nwannekanma and Gbonegun 2019; Abdul et al 2018). Infrastructure and Project Authority (2022) considers infrastructure necessary to a nation's development, economic growth, and prosperity. For instance, with 70 projects in the UK Government's Major Project Portfolio (GMPP), the whole life cost is £339bn (in 2019) with expected monetised benefits of £356bn. Infrastructure is beneficial to the welfare of the citizenry (Khairuman et al. 2019). Examining the connections between welfare, citizenship, and infrastructure, Gunn et al. (2022) argued that infrastructure plays a crucial role in the everyday experience of citizens within the city and outside of the urban areas, functions as mediator of citizen privileges, and also serves as "channels" and "connections" supporting certain forms of behaviour (such as the acceptable everyday practices and needs of citizens, work activities or working unproductively) through the built environment. Even though infrastructure is regularly overlooked as posited by Latham and Layton (2019), it is an essential part of how cities and rural areas work as social – technological systems. As noted by Lezak et al. (2019) the "corporate social responsibility" (CSR) concept appeared to be the feature of dialogue about infrastructure and conflict.

As the backbone of a healthy economy, Puentes (2015) considers infrastructure as a connection from households through urban areas to considerable quality opportunities for education, employment, and healthcare. Considering the infrastructure value and policy within a society, infrastructure is connected with provision of technical solutions and stimulating economic growth. Han et al. (2020) believes that developing nations should significantly invest in infrastructure development to address infrastructure needs for increased economic development. In view of this, developing countries are making efforts to improve their infrastructure for economic advancement (Hamma-adama et al. (2021). Furthermore, Hussain et al. (2022) asserts that infrastructure enhances the sustainability performance of future generations. The abandonment of these structures considered as built assets causes unsustainability in the built environment in many countries, especially the developing nations (Adeyemi et al. 2017a). Consequently, the abandonment of infrastructure causes environmental nuisance, unsafe and unhealthy conditions, becomes a threat (with increase in criminal activities) and slows down development (Oyedele 2012; Abdul et al. 2018; Tavakoli et al. 2021). Hanachor (2012 p. 34) defines abandonment:

> *"….. the act of giving up an action on something completely, with no certain intention of when to resume*".

Nnamseh et al. (2021) and Doraisamy et al. (2015) both agreed that abandonment is a global phenomenon. Abandonment could emerge in various forms such as agricultural land abandonment (Moyo and Ravhuhali 2022), gas well abandonment (Zheng 2021), village abandonment (Nizamutdinov et al. 2022) and public buildings abandonment (Akande et al. 2021).

Shane (2012) further expressed the term *abandoned building* as relevant to being unoccupied, possibly "boarded up", untidy with graffiti, scattered with garbage and in a muddle of grave desolation. Several studies such as Olalusi and Otunola, (2012) Ubani and Ononuju, (2013); Doraisamy et al. (2015); Nsiah-Asamoah (2019), Aiminhiefe (2022) further referred to abandoned buildings as structures that commenced occupation at an earlier date and stopped for one reason or another. These structures are not limited to buildings alone; industrial structure, dam, roads, bridges and factories, electricity, communication projects etc.

Infrastructure abandonment in the context of this research includes structures that were initially occupied for a certain period (more than one year) and subsequently vacated with no indication of when to resume utilisation (Ariffin et al. 2018 and Ekele et al. 2022).

The problem of abandoned buildings has remained unsolved and has a ripple effect on the whole economy of the nation and the construction industry in particular (Damoah et. al. 2020; Ogunnusi et al. 2022). Abandoned buildings have adverse effects on stakeholders (Damoah et. al., 2020) causing severe problems for parties such as the client, developer, consultants, and contractors. Mitigation plans to address infrastructure abandonment are needed to prevent the problem from re-occurring (Ariffin et al. 2018). According to Alao and Jagboro (2017), the continual increase in building abandonment has contributed to an infrastructure deficit and inadequacy in Nigeria. Abdul (2018) considered the impact of abandoned infrastructure in Nigeria as enormous and worrisome with an annual loss of £210 million before 1999, ₦5trillion (£8.15billion) abandoned government projects across the country and £1.6 billion infrastructure deficit. In 2019, out of N8.9 trillion budget on capital infrastructure, Nigeria voted for 24% out of which 57% of the vote at N1.2 trillion was released (Atoyebi 2021). The topography of the country is laden with abandoned infrastructure (such as 4000 abandoned Federal Government buildings in Nigeria at an estimated cost of about N300 billion (£6.3M) at all tiers of governance from the local to the states and Federal governments (Olalusi and Otunola 2012; Daniel and Ibrahim 2019).

Doraisamy et al. (2015) reviewed abandoned structures in Nigeria and Malaysia and asserted that abandonment of structures is plaguing the building industry. In addition to the construction industry in Nigeria, Akogun (2014) also mentioned the negative effect of this abandonment on even residents near these structures.

Even though Nigeria is considered as the largest African economy, when compared with her counterpart - South Africa - Figure 1.1, adequate provision for the populace is required in the area of economic growth and a better standard of living as Nigeria tops the list of countries below the extreme poverty line at 11.9% (Figure 1.2).

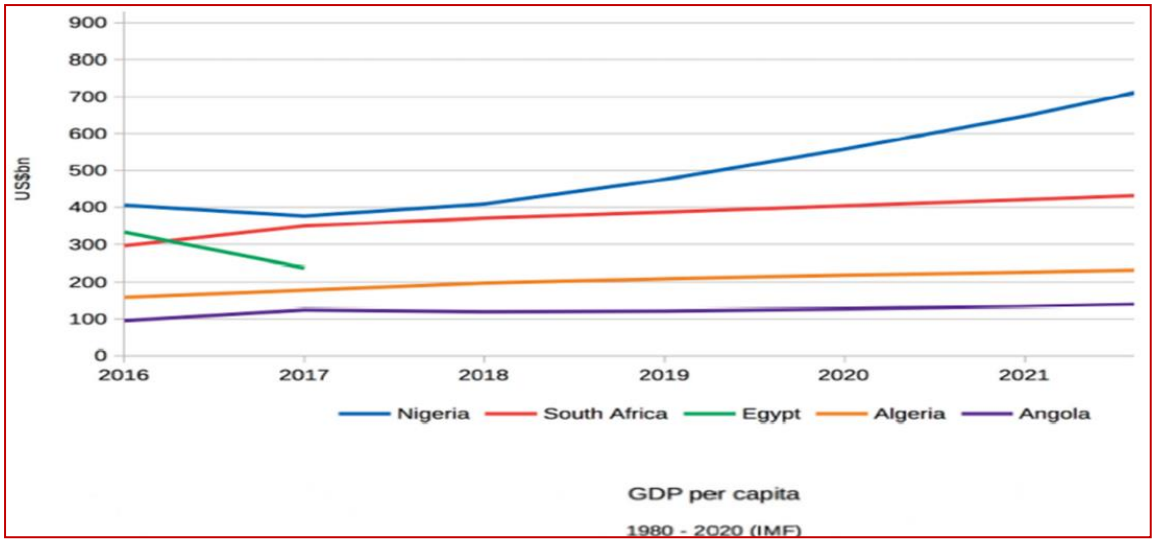


Figure 1. 1: GDP per capita of the top 5 African countries

Source: IOL Staff Reporter (2018)

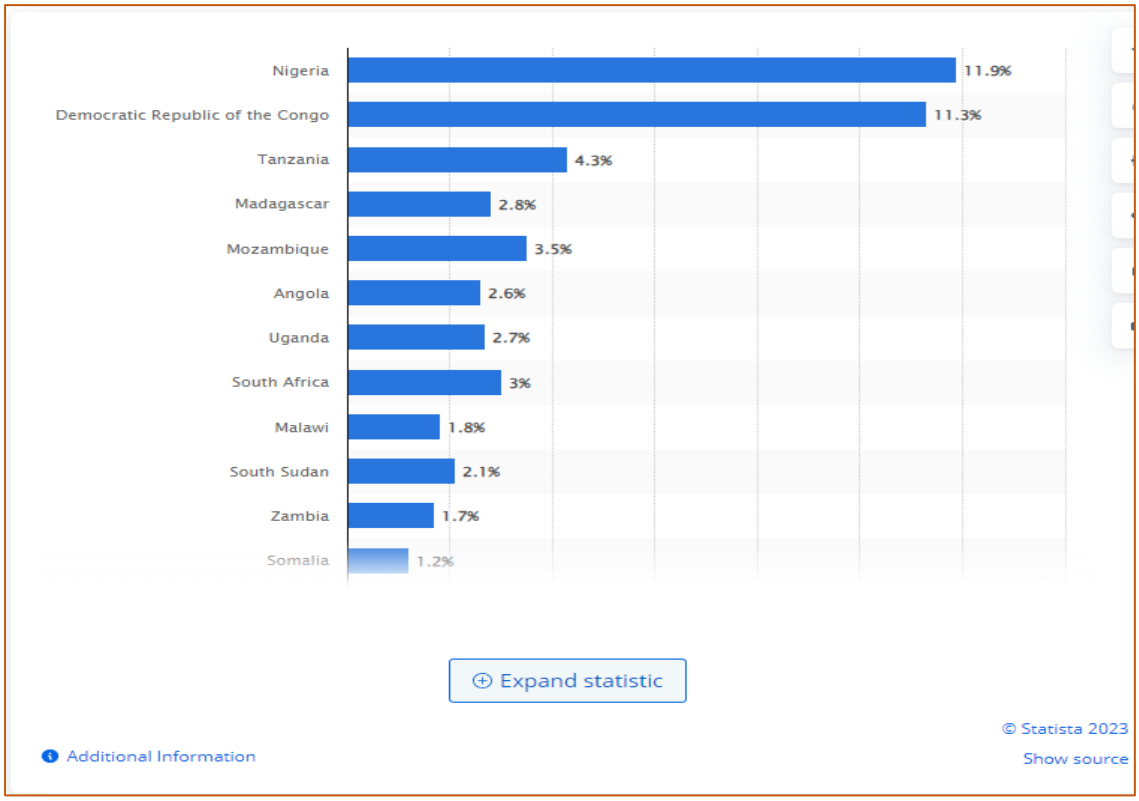


Figure 1. 2: Nigeria on top of the list of countries below extreme poverty line in 2022

Source: Statista 2023

The population of Nigeria as of 2016 was 186million and 224million in 2023 (Worldometer 2023). According to the World bank, 49% of the population resides in urban regions with a projection that this will grow to 66% by 2030, consequently mounting pressure on providing infrastructural

requirements (Atanda and Olukoya, 2019). The infrastructure requirement aspect could be expanded to the wider implications of population growth, not just for Nigeria as a whole, but for the cities. The small cities such as Oyo in Nigeria are "becoming major urban centers in their own right", progressively growing alongside the larger cities (French 2022 p.3). With these areas and also the so-called "newborn cities", the projected populations of the coastal area of Abidjan-Lagos will rise to 51million by 2035 as against a decade projection from now of 40million inhabitants (French 2022). If nothing is done to address the problem and the current rate of abandonment continues into 2035, a percentage of the new infrastructure will inevitably be abandoned.

Strategic and coordinated infrastructure investment is imperative to establish a structure of cities that protects economies and population from environmental risk and guarantees economic prosperity (Ahmad et al. 2019). Zhang et al (2021) recognises the reduction of investment in building development to that for economically utilising, reusing and regenerating existing, abandoned structure as an approach to sustainable development goals. The "aspiration" of sustainable development is not only about erecting new developments but also about developing abandoned environments (Pavlovskis et. al. 2017). Taking a cue from the UK's attempt of developing sustainable infrastructure, the national review of progress towards the Sustainable Development Goals in the United Kingdom, as stated by the HM Government (2019) did not only concentrate on building new infrastructure, but also rehabilitating old and dilapidated ones e.g. "*Thousands of new homes to be built on regenerated brownfield land in England*" with the intention of transforming communities and levelling up the country (UK Government 2023). This will help to ensure that abandoned urban areas are brought back to use to boost the economy.

The Federal government of Nigeria recognised, in 2017, the importance of the implementation of 17 sustainable development goals to their socio-economic development progress (NVR 2017).
This is to the extent that 41% of the total budget allocation in Nigeria's 2016 budget was targeted at infrastructure development. This may be rather contradictory to what entails in the current Nigerian environment. With critical consideration of two of the 17 goals - SDG 9 (Industry Innovation and Infrastructure) and SDG 11 (Sustainable Cities and Communities) - the concern is why the abandonment of these infrastructure as recorded in other studies by Abdul et. al. (2018); Amadi (2019); Okafor et al. (2018); Ogunnusi et al (2021). This is in contrast to Nigeria's expectations of sustainable cities and communities' delivery.

This research seeks to understand the challenges caused by abandonment and proffer possible solutions to the menace. Identifying issues of abandonment and investment in infrastructure should not be limited to the call for building conversion by Madeddu and Clifford (2022) or the words of Hull's (2021) blog-"Tenders are being awarded for new development when these older and abandoned buildings and structures should be given preference and utilized before we build more buildings", but should be explored further in academic research such as this study.

Despite the extent of abandoned infrastructure in Nigeria (Chapter 2, Table 2.3, and Table 2.4), and recommendations from scholars such as Abdul et al. (2018); Akande et al. (2021), solutions have yet to be applied in practice, compelling the view of the solution from a different perspective. None of these studies have attempted to provide a systematic approach for addressing the problem of abandoned structures. For instance, Abdul (2018) evaluated abandoned buildings in Nigeria, and recommended arrays of ways these buildings could be used, but none of the suggestions have been applied. The question that emerges is how can the appropriate solution be identified?

To achieve this, this research evaluates the sustainability model which comprises of five attributes (social, economic, environmental, political, and technical - SEEPT), four alternatives and ten criteria (Kamari et al. 2017) obtained from different literature to develop of a decision-making model for policy makers in identifying the most sustainable solution to address abandonment.

1.1 Research Questions

With the introductory section of this chapter, some questions were developed throughout the study from difference sources, further details are provided within the methodology chapter. The sets of questions are presented below:

- What are the causes of abandonment of infrastructure and impact factors that the abandonments contribute in Nigeria?

- What are the possible solutions that can be adopted to address this infrastructure abandonment?

- What would be the form/nature of a tool that could address abandonment?

- With arrays of possible solutions, what is the level of knowledge of the application of techniques and /or tools among the decision makers in attaining the optimum solution?

1.2 Aim

To explore the infrastructure sustainability, the causes and impact of abandoned infrastructure in Nigeria, and develop a model to enhance the decision-making process in redevelopment of abandoned infrastructure in Nigeria.

1.3 Objectives

The aim will be attained with the following objectives:

1) To explore the sustainability of infrastructure in Nigeria in line with the UN sustainable development goals.

2) To determine the causes of infrastructure abandonment in Nigeria.

3) To evaluate the impact of factors contributing to the causes of these abandonment.

4) To identify possible remedies that will enhance sustainable development of abandoned infrastructure.

5) To explore techniques and / or tools that could address infrastructure abandonment.

6) To design, test and validate an identified innovative tool (including the level of knowledge relevant to the factors covered by the tool) with academia and built environment professionals.

1.4 Scope of the Research

This research concentrates on addressing the problem of abandonment of infrastructure (i.e abandoned buildings) in Nigeria. This thesis presents an academic research examination established on relevant literature and primary data collection from built environment professionals.

Being an academic study, the research and the methodology was limited to a four- year study timeline (Figure 1.3) established on existing and accessible literature from academic databases and primary data collection from experts. This research explores the subject matter from the perspective of infrastructure (government public buildings) in Nigeria.

1.5 Problem Statement

It is disheartening that infrastructure (mentioned in Chapter 2, Table 2. 3) that would have enhanced the economy of Nigeria were abandoned. More so, these abandoned structures are negatively affecting the environment by generating social problems, health threats and marring environmental aesthetics (Amade et al. 2015).

There is no country without examples of abandoned infrastructure - United State, Saudi Arabia, Spain, Russia, Malaysia all have their stories to tell (Hoe, 2013; Doraisamy et al. (2015); Mac-Barango 2017). It could also be that a certain level of abandonment is inevitable, particularly in the context of infrastructure, if only due to long duration (and changes in society needs during that duration) of such buildings (Atkins 2017). Nigeria's situation requires further attention considering the government structures abandoned as seen in Figure 1.3. Despite attempts to curb the occurrence through the study of Amade et al. (2015)**;** Ubani and Ononuju (2013); Olumide, Olalekan & Falade (2018); Cole (2022) on abandoned infrastructure, the problem persists (Philip *et al.* 2012, Hoe 2013). To make Nigeria at par with the global community (For example, a recommendation of a functional model towards restoring abandoned public structures – Akande 2021) in seeking to meet the infrastructure deficit, this research evaluates the causes of abandonment of infrastructure in Nigeria. With the availability of multiple option of solutions, the focus is to design, test and validate a decision-making model that will underpin the policy – makers process of optimum sustainable solution selection.

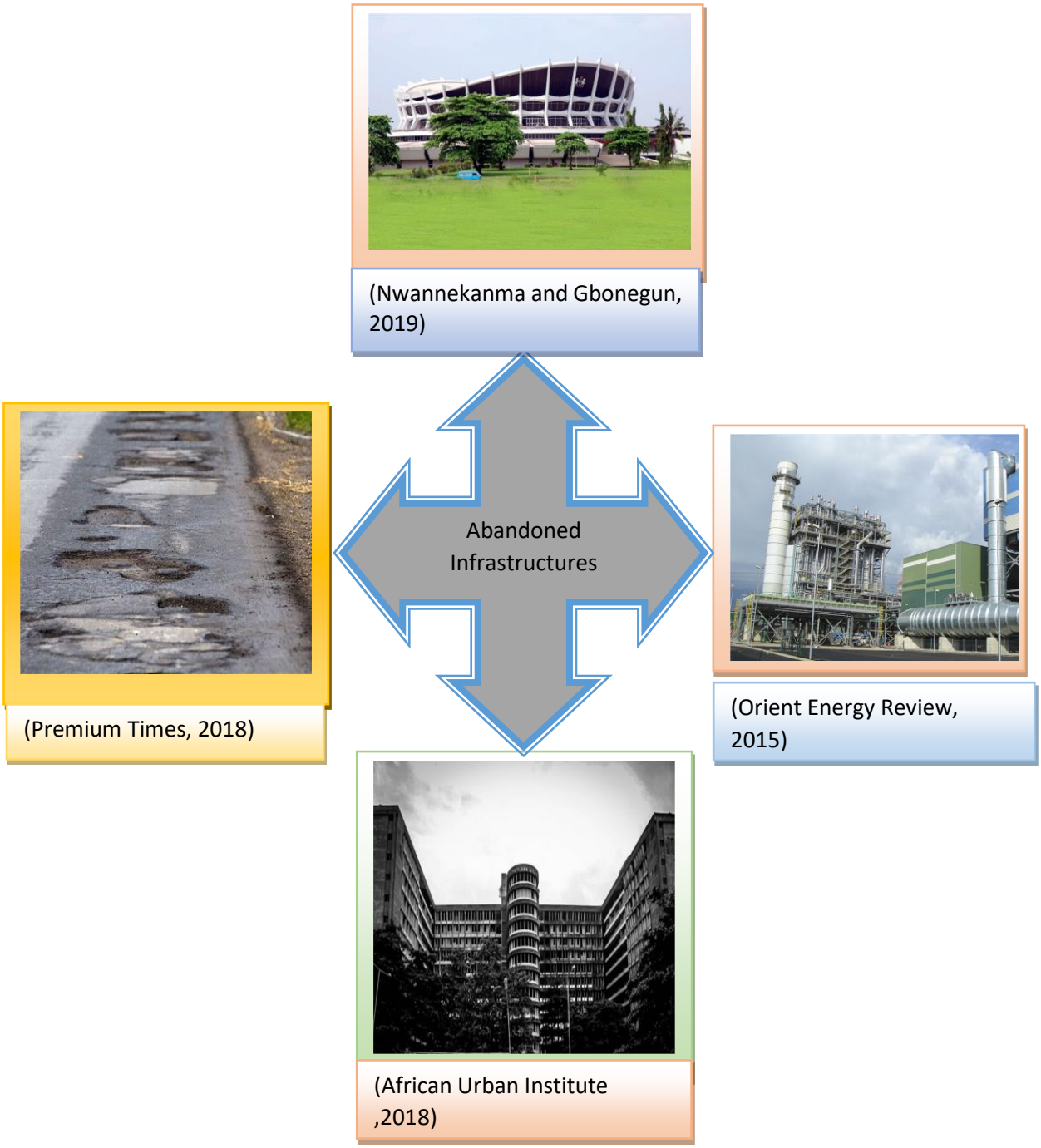


Figure 1. 3: Abandoned Infrastructure in Nigeria

1.6 Research Methodology

The synopsis of the methodology for this research is presented as a guide in this section. Additional details of the research methodology are discussed in Chapter Three. To attend to each research objective, it was deemed imperative to adopt an appropriate research method that will enhance sufficient data collection by the researcher, resulting in comprehensive analysis and interpretation of findings. With this in mind, the study commenced with a broad review of literature to comprehend the sustainability of infrastructure in Nigeria (Section 2.1 & 2.2), the causes of abandoned infrastructure and the impact or factors contributing to the causes and then narrowed the scope to public buildings (Section 2.3). The literature review enhanced the researcher's knowledge in the theory around sustainability and infrastructure. Gaps in literature were also identified in addition to understanding how the study can address some of these gaps adequately with decision making framework as one possible solution (Section 2.6) (Bryman 2011; Saunders et al. 2016; Hart 2018). Pragmatic research paradigm was adopted from literature review which resulted in a mixed method approach (Section 3.4). With this sequential explanatory mixed method was embarked on to collect quantitative and qualitative data. A questionnaire and semi-structured interview were adopted (Section 3.6, 3.7 & 3.8) to address abandonment and provide possible solutions to the decision makers. The decision makers in Nigeria context could also be experts or professional in the built environment who may be invited as part of the committees to deliberate on the best way to address the problem with the development of the report based on the findings. Moreso, there are different level of decision makers established at different level of government from federal, states to local authorities (Mukherjee et al. 2023; Keriafe and Tiamiyu 2021). To this effect, a decision-making model was developed, tested qualitatively and quantitatively (Section 3.8.4) to ascertain the functionality of the model, and its enablement to facilitate decision making process.

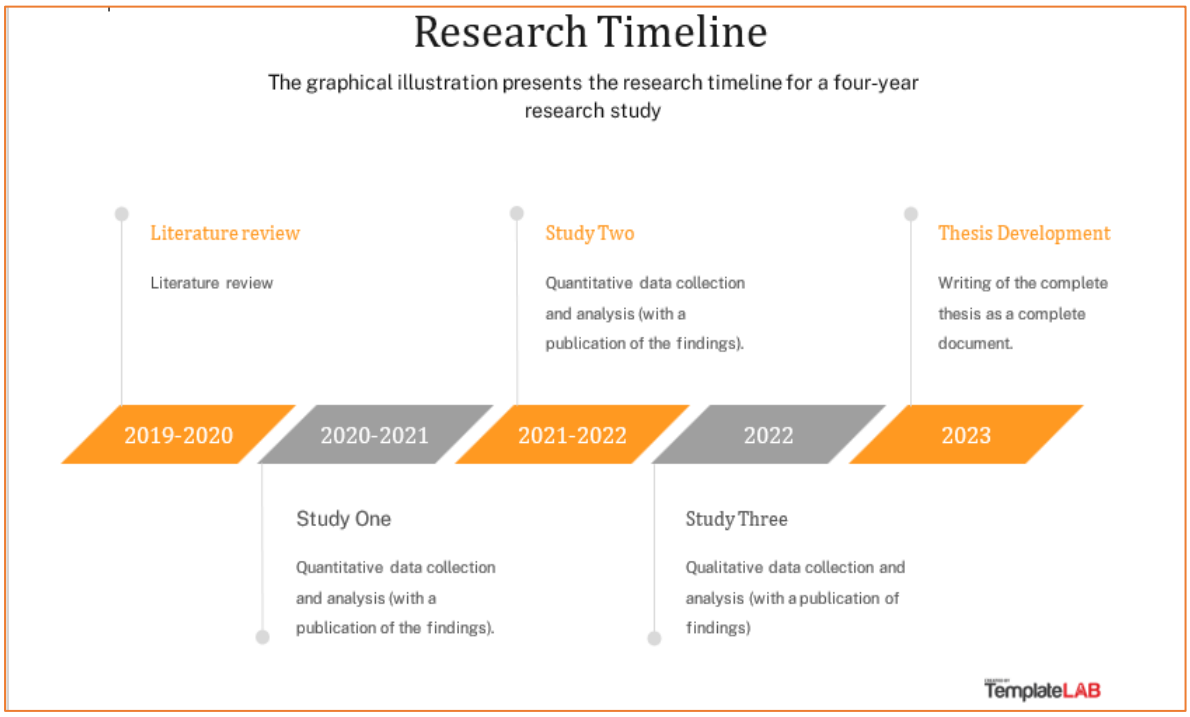


Figure 1. 4 Timeline for the research

Source: Template adapted from TemplateLAB to generate the content

1.7 Impact

This research work will potentially impact the government, professional bodies, and the society sustainably with the 'triple bottom line' (TBL) (Refer to Chapter 2, Section 2.1.2) consideration. This will impact the economy of the country, the aesthetics of the environment and the stability of the society. The addition of political and technological sustainability consideration in the context of this research will also contribute to body of knowledge and create a pathway for extended research in the Nigerian AECOO (Architects, Engineering, Construction, Owners, and Operators) Industry. The research will also contribute to both academic and professional bodies of knowledge, from continuous unsustainable development of infrastructure to aligning with sustainable development goals in the redevelopment of these abandoned existing Infrastructure. This research will also create an insight into efficient decision-making attempts at selecting optimum solution. The original contribution also focused on the examination of a decision-making procedure validated by professionals in the built environment.

1.8 Overview of the thesis

Chapter One - Provides the contextual basis of the study including the research questions, the aim, the objectives, and the problem statement of the research. The impact of the study is also discussed.

Chapter Two – Presents the literature review of the study which includes infrastructure and sustainable development in Nigeria, the socio-economic impact, abandonment, and redevelopment in Nigeria in comparison to other countries, the adoption of Multi-Criteria Decision Making and model development consideration and the adoption of the multiple 5Rs concept.

Chapter Three - Outlines the comprehensive methodology adopted within this research. It encompasses the mixed (quantitative and qualitative) method deployed, discusses the MCDM method, SPSS, Qualitative content, and thematic analysis (NVIVO) and TOPSIS analytical tools.

Chapter Four – Examines and discusses the quantitative and qualitative data collection, findings and analysis as identified in Chapter 3.

Chapter Five – Explores the procedure of the model development.

Chapter Six – Presents the testing and the validation of the model based on MCDM - TOPSIS.

Chapter Seven – Discussion, Conclusions and Recommendation.

1.9 Chapter Summary

This chapter introduced the study, including the research questions, the aim, and the objectives. The research methodology, the scope of the research, the problem statement that resulted to the research as well as the research impact were also discussed.

A synopsis of the need for functional and sustainable infrastructure was discussed. The abandonment of these structures is resulting to environmental nuisance, hindered economic growth and social menace especially when compared with other countries such as United Kingdom and United State of America. The chapter argues that the redundancy of these abandoned buildings present that Nigeria situation requires further attention. From the problem statement, this chapter presented the summary of the studies conducted by authors from previous literature. However, the argument of this chapter is that, with the causes of the abandonment and their negative impact, emerging array of solutions from literature are becoming circular. Hence, the necessity for a systematic approach to identifying the optimum solution to address the abandonment. In this regard, the appropriate research questions within the limit of the aim and objectives were presented in the chapter.

CHAPTER TWO: LITERATURE REVIEW

2.0 INTRODUCTION

This chapter further develops the background of this research by proffering supplementary context to Chapter One. It evaluates infrastructure abandonment and sustainability in Nigeria, comparing it to the situation in other countries. This chapter also includes a comparative study of abandoned infrastructure redevelopment in selected countries and Nigeria. Furthermore, the sustainability consideration of addressing abandoned structures is examined leading to the identification of two pillars (political and technological) additional sustainability attributes to the three pillars (social, economic, and environmental) of sustainability. Also included is a review of alternatives to the redevelopment of abandoned infrastructure and criteria relevant to enhancing the redevelopment potentials. In addition, a possible decision-making model for sustainable redevelopment is also discussed.

2.1 Definition and Segments of Infrastructure.

Bradley et al. (2016) defined Infrastructure as "the basic physical and organisational structures and facilities needed for the operation of the society or enterprise".

The term infrastructure emerged in France in 1880 and was later applied in the 1920s to the complex connections of roadways, waterways and communication systems underpinning the United States military organisations (Bowker 2018). According to DeFazio et al. (2021); Proag (2021) and OECD (2021b), Infrastructure can be public or private scheme in a nation, region, or state which include utility lines, roads, and public buildings. Chinowsky and Helma (2021) states that infrastructure includes an extensive range of public structures such as hospitals, airports, schools, medical facilities, and government buildings.

Irrespective of infrastructure being publicly or privately owned, Uddin et al. (2013) considers infrastructure as comprising facilities such as health and education services, transportation services, public buildings, and other recreational areas. Jetel (2016) also listed infrastructure as transportation facilities, land, technical facilities, buildings, civic amenities, e.t.c that are positioned and utilised in the public benefit. Based on Chinowsky and Helma (2021); and Bradley et al. (2016) studies, infrastructure assets can further be structured into six areas (Figure 2.1):

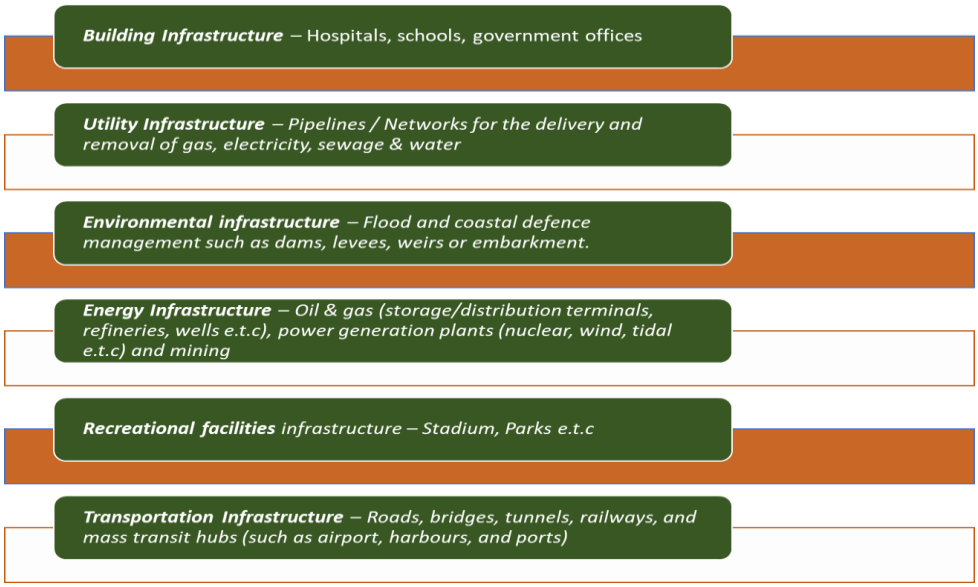


Figure 2. 1 : Six areas of infrastructure assets

Within the context of this study, infrastructure can be specifically defined as public buildings that contribute to the sustainable operation and well-being of the citizens. Sustainability is considered as a requirement for the purpose of this study.

2.1.1 Categories of Infrastructure.

The term 'infrastructure' (Figure 2.2) has been explored by Toppr (2022) who considered infrastructure as being social (e.g affordable housing, schools, and hospitals) and economic (e.g sewage, roads, water, power, communication and airport). Traditionally, infrastructure has been divided into two categories or types: Hard (physical things – airport, roads, and buildings) and Soft (social capital, institutions, and basic technologies) that are necessary in the built environment to deliver quality of life and required services, and to also support the economy (Dyer et al. 2019; Roberts and Drake 2021). The Corporate Finance Institute (CFI) (2023) categorised infrastructure as being soft, hard, or critical with further illustrative example indicated in Figure 2.2. Soft infrastructure comprises all the institutions which are essential to maintain the social, health, economic and cultural standards of a nation, hard infrastructure comprises the sizeable physical networks required for the operations of a modern industrial country while critical infrastructure encompasses all assets that are crucial to the operation of an economy as defined by the government (Olanipekun 2014).

CFI (2023) stated that soft infrastructure helps to maintain a healthy economy. According to Dyer et al. (2019), soft infrastructure involves social grouping, services, and personal skills while classifying the hard infrastructure as public space, utilities, and buildings.

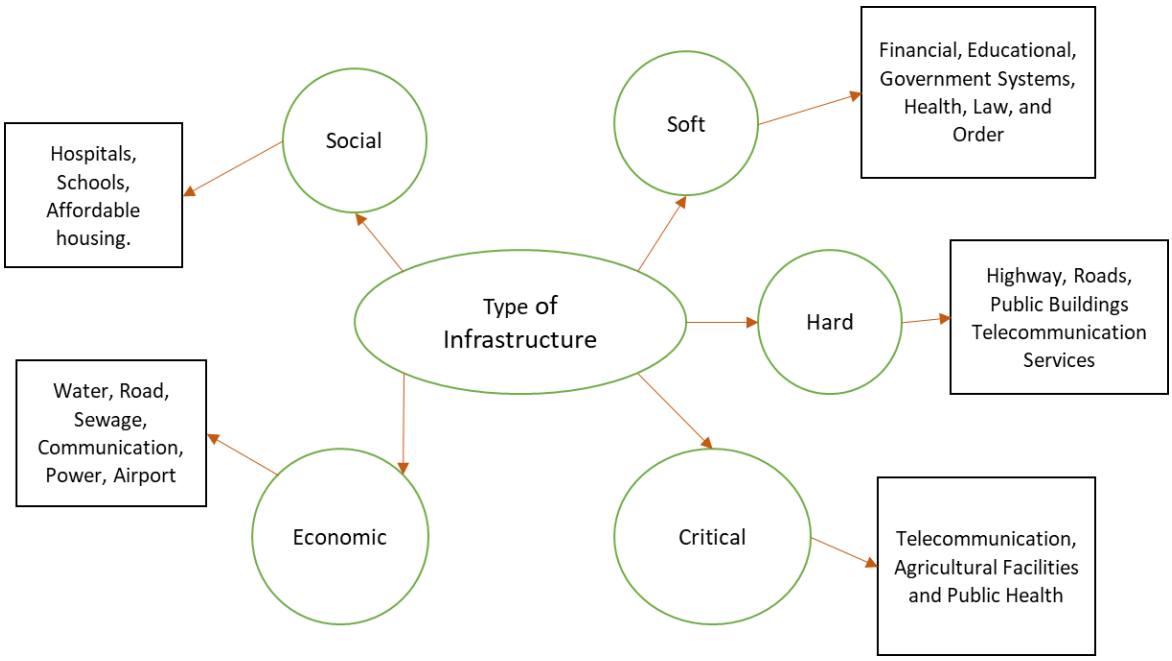


Figure 2. 2 : Types of Infrastructure

Source: Adapted from Toppr 2022, Corporate Finance Institute (2023)

2.1.2 Infrastructure Development and Sustainability in Developing Countries

Nigeria is one of the developing countries located in the sub-Saharan western part of Africa (Figure 2.3) (WorldAtlas 2017; Chepkemoi, 2019). According to Ngoran et al. (2016) Sub-Saharan Africa (SSA) geographically is the extent of the Africa continent that falls south of the Sahara Desert (See Figure 2.3). Although the World Trade Organisation (WTO, 2023) offers no definition of developing countries, with each member country declaring their position as either developing or developed, Kuepper (2019) defined developing countries based on their extent of integration into the global financial system and market diversification. The 152 developing countries around the world according to WorldData (2023) and Amadeo (2019), are characterised by their level of development and economic advancement. Hamma Adama et al. (2021) noted that the developing countries are endeavouring to enhance their infrastructure to improve economically.

According to the United Nations on Trade and Development (UNCTAD 2022) report, the share of people inhabiting the developing countries due to population growth has risen from 66% in 1950 to 83% and is expected to reach 86% by 2050. This growth can be expected to trigger increased demand for infrastructure. These countries include the whole of Africa, the whole of South and Central America, almost all Asian countries and several other Island states.

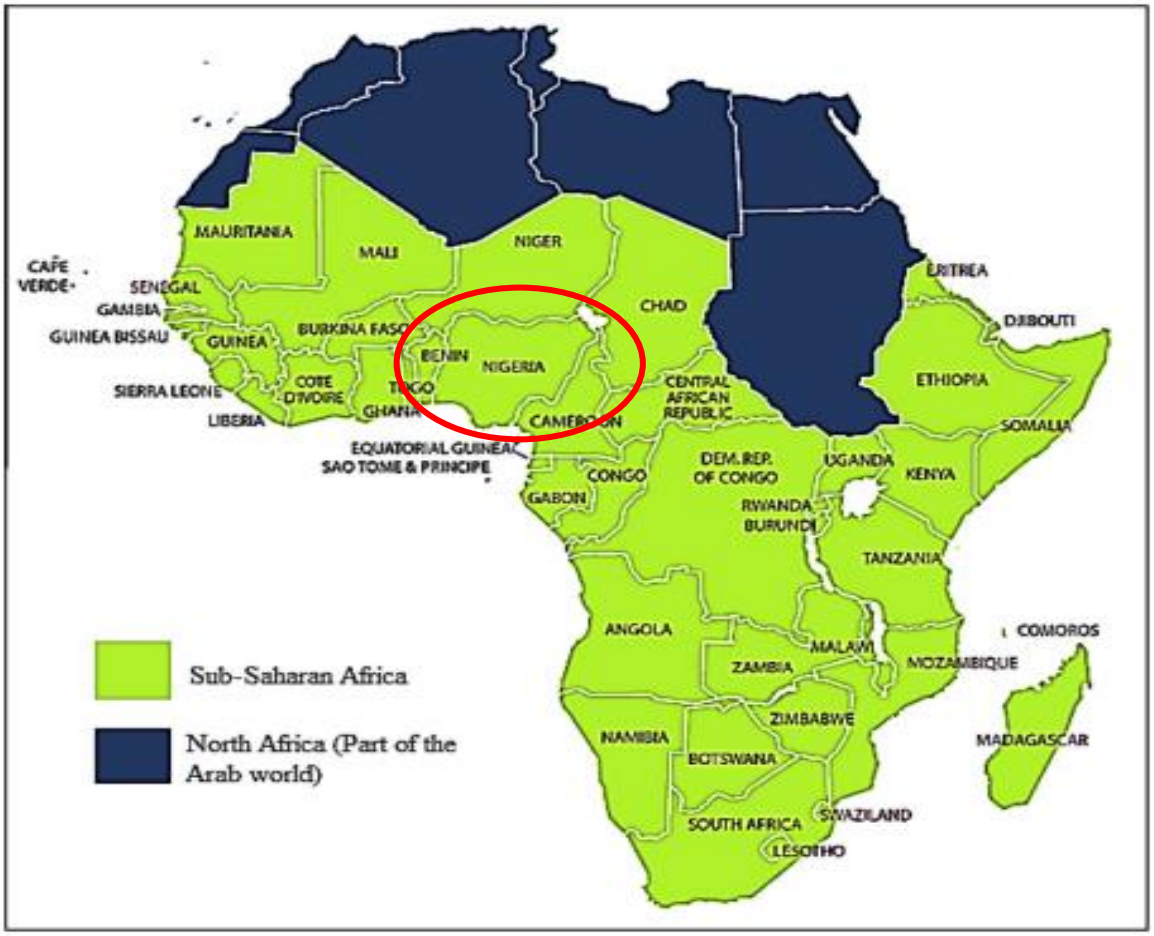


Figure 2. 3: Location of Sub - Saharan Africa

Source: Ngoran et al. (2016)

Different criteria for defining developing countries, provided by selected international organizations such as United Nations Development Programme (UNDP), The International Monetary Fund (IMF) and World Bank, are discussed in Table 2.1**.** Studies from Benson (2022) and Sasu (2023) classified African countries according to their level of human development and identified Nigeria as 26th position of 0.54 human development index (HDI) score while Mauritius and Sudan are the countries with the highest (0.8) and lowest (0.39) human development index (HDI) respectively. Infrastructure development promotes HDI by improving incomes, productivity and establishing growth channels (Liu et al. 2023; Mohanty et al. 2016; Djokoto 2022).

Table 2. 1 : Different categories of developing countries from selected international organisations

	UNDP	IMF	World Bank
Name of Developed Country	Developed Countries	Advanced Countries	High income countries
Name of Developing Country	Developing Countries	Emerging and developing countries	Low- and middle-income countries
Development Threshold	75 percentile in the HDI distribution	Not explicit	US$6,000 GNI per capita in 1987-prices
Subcategories of developing countries	(1) Low human development countries (2)Medium human development countries, and (3) High human development countries	1) Low-income developing countries and (2) Emerging and other developing countries	(1) Low-income countries and (2) Middle-income countries

Source: Gbadamosi (2023)

The developing countries in Sub-Saharan African also acknowledge the advantages of sustainable infrastructure (The Economists 2019). For instance, Nigeria identified infrastructure as the fundamental driver that can fast-track the social, economic and environmental stability required in attaining the "triple bottom line **(**TBL)" (Figure 2.4) (Munyasya and Chileshe 2018). TBL is a joint sustainability concept founded by John Elkington in the mid-1990s which emanated from requirements that include social, economic, and environmental dimensions (Arslan and Kisacik 2017; Munoz - Pascual 2019). Generally, the prominence given to sustainable development orchestrated the development of the TBL concept despite its initial existence in businesses, companies, and the commercial environment (Nogueira et al. 2023).

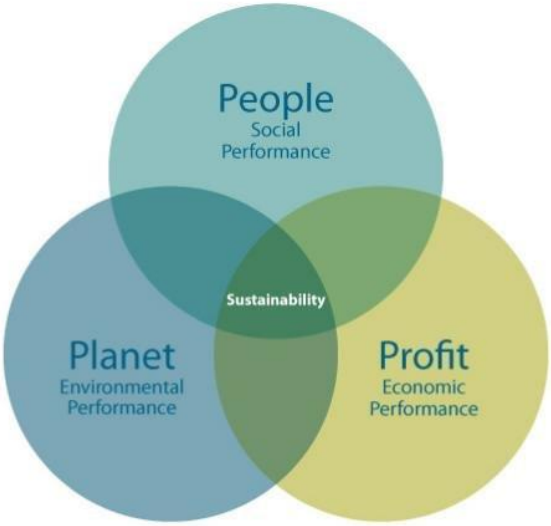


Figure 2. 4 : Triple Bottom Line of Sustainability

Source: Arslan and Kisacik (2017)

To ensure a longer use of government assets while also playing a major socio - economic role, there is a need for conformity of infrastructure development to the TBL performance standards of sustainability which are social, economic, and environmental performance (Acai and Amadi-Echendu 2018). Yanamandra (2020) further defines sustainable infrastructure in relation to United Nations Sustainable Development Goals (UN SDGs**)** as a "project commissioned with institutional mechanisms to manage or mitigate the adverse impacts of the project by monitoring the triple - bottom line criteria all through the course of the project life - cycle…." According to Slaper and Hall (2011 p.4), TBL "captures the essence of sustainability by measuring the impact of an organisation's activities on the world including its profitability and shareholder values, and its social, human and environment capital". Slaper and Hall (2011); Sridhar and Jones (2013) and Hourneaux et al. (2018) further stated that TBL is not about definition but measurement (See Section 5.1.2).

Infrastructure development has not been given appropriate attention by either the Nigerian Government or successive governments elsewhere in Africa (Olufemi et al. 2013; Gaal and Afrah 2017; OECD/ACET 2020).

2.1.3 Infrastructure Development and its economic value in Nigeria

A healthy economy as noted by Elijah and Olumuyiwa (2011); Ariffin et al. (2018) typically experiences growth in its construction industry. Great countries achieved their enviable status through accruing suitable and maintainable infrastructure.

The World Bank estimated that for every unit of funding invested by government on infrastructure, there is an equal percentage/unit increase in Gross Domestic Product (GDP) (Chisa et al. 2015). Infrastructure is a product of strategic processes by the leadership of any nation (International Transport Forum 2021). Infrastructure could be owned by the public or private sectors. An example of private infrastructure which often implies business providing services on behalf of the government could be shipping services and private ferries, toll bridges, and dock and port facilities (Reliance Foundry 2023). However, the focus of this study is on public sector building abandonment.

The Federal Government of Nigeria at the national, state, and local levels propels infrastructure as the focal point of their "administration and policy enactment" for social and economic stability (Ogunnusi 2015). Government invests in construction projects in the form of schools, hospitals and dams, etc. to enable the provision of public goods and services in the areas of education, health and electricity (Staples and Dalrymple 2011; Anomaly 2015; Indeed Editorial Team 2023). With this, alignment of investment is required with objectives and missions of the project implementation to realise value for money (VFM).

Ogbonnaya et al. (2019) states that Nigeria is anticipated to surpass a population of 300million people by 2050. As of 2016, Nigeria's population was estimated at 186million. According to the World Bank, the share of the population residing in urban centre is estimated to grow from 49% in 2016 to 66% by 2030, with attendant pressures on the infrastructure (Atanda and Olukoya 2019). This is also evident in the economic indices and poverty ratio (percent living on less than 1.90 USD a day - see Figure 2.5) in Nigeria compared to other countries (Kazeem 2018; IOL Staff Report 2018; Global Economy 2023).

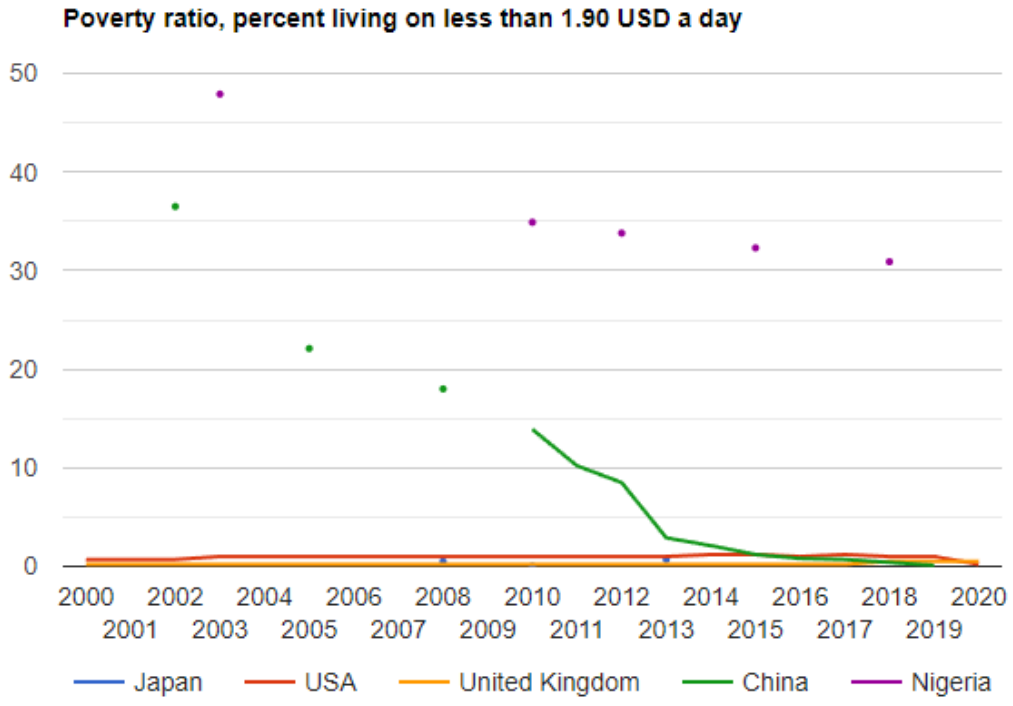


Figure 2. 5: Poverty indices in Nigeria compared to other countries.

Source: Global Economy (2023)

2.1.4 A need for Infrastructure Provision in Nigeria

Conceptually, infrastructure comprises the provision of amenities for sustaining national advancement (Olanipekun et al. 2014; and Ojo 2022). A sustainable infrastructure as explained by Amritaserve (2019) places emphasis on the care of society, community and environment, both of today and that of future generations.

Sustainability is essential for the conservation of infrastructure to meet current needs and the needs in the future through environmental viability, cost effectiveness, social equitability, and resilience (Amiril et al. 2014). In 2005, the government of the United Kingdom stated its goal to be positioned as one of the leaders of sustainable procurement by 2009 (Walker and Brammer 2009). This goal was revisited in 2009, and again in 2013, with evolution of a Framework for a National Action Plan and is yet to lead to a quantifiable target (Davis et al. 2013; Al-Nabahani et al. 2023). "The Procurement Working Group" recommended some changes to the structure and analysis of United Kingdom infrastructure procurement in order to build an enabling environment. Although one of the parastatals (Ministry of Justice) in the United Kingdom evidenced the efforts to improve with the development of "Sustainable Procurement Policy" to improve and manage the contract management processes by appointing a Sustainable Procurement Champion responsible for raising awareness (Ministry of Justice 2019). *The Construction Playbook* government guidance on sourcing and contracting public works projects and programmes by HM Government (2022) demonstrates the UK government's continuous effort towards a positive outcome on sustainable procurement.

The National Voluntary Review (2017) reported that infrastructure development highlighted by the Nigerian government in its development agenda is generating significant outcomes, such as a 35% contribution of the infrastructure sector to GDP. This is not only the case of delivering sustainable infrastructure as investigated by Arowosafe et al. (2018), but rather the case of ensuring the sustainability of the already provided infrastructure. Sustainable development should integrate economic, social and environmental qualities concurrently to work efficiently (Chong et. al. 2017). Weinberger et al. (2015) demands the balanced integration of TBL environmental, social, and economic dimensions as an urgent shift in policy approach. Pujiati et al. (2019) presented guidance on conducting integration through "learning, planning, implementation and evaluation". Ari and Koc (2018) view public infrastructure as performing a role in guaranteeing and supporting the welfare of a country by sustaining the United Nations Sustainable Development Goals.

2.2 The origin of sustainable development - the UN sdgs

According to Kates et al. (2016), sustainable development emanated from four key themes (peace, freedom, development and environment) that were of collective concern after the Cold War which ended in 1991 (CSEEES 2023). These key elements continued to be prominent to the extent that "world commissions of notables" were established to review such global concerns. With the production of vital documents from international conferences, sustainable development emerged into a two-fold emphasis on development and environment in the protection of ecosystems, species, and resources. Sustainable development was further expanded by the 2002 World Summit with the broad use of three pillars of sustainable development: economic, social, and environmental (Purvis et al. 2018). Figure 2.6 displays the list of the 17 United Nations Sustainable Development Goals (UN SDGs).

The major standard of sustainable development fundamental to all others is the integration of economic, environmental and social concerns into all features of decision making (Emas 2015). Emas (2015) further distinguished sustainable development into weak and strong forms, defining the former as such that "aggregate level of capital" only matters while the latter recognises the exceptional

natural resource features that cannot be substituted by industrial capital. Responding to "why Nigeria is not yet sustainably developed", Odunjo (2013); Lawrence et al. (2020) and Ogunkan (2022) suggested the presence of a weak sustainability development in Nigeria and that the country is still trying to achieve sustainable development which it is suggested here could be an opportunity to begin the linking of sustainability to abandonment.

This argument can be viewed from the relationship between infrastructure abandonment and two of the SDGs (9 & 11). For instance SDG goal 9 - Industry Innovation and Infrastructure seeks to build resilient infrastructure. With the benefit of this resilience in mind, abandoned infrastructure which can reduce the quality of life and economic growth can be addressed (Prindle et al. 2018). On the other hand, Sustainable Cities and Communities (SDG 11), which is also related to SDG 9, highlights the importance of sustainability within cities (UNSDG Report 2022). In Watrobski et al. (2022)'s viewpoint, a sustainable city which includes the development of infrastructure should be economically productive, socially inclusive, and environmentally safe.

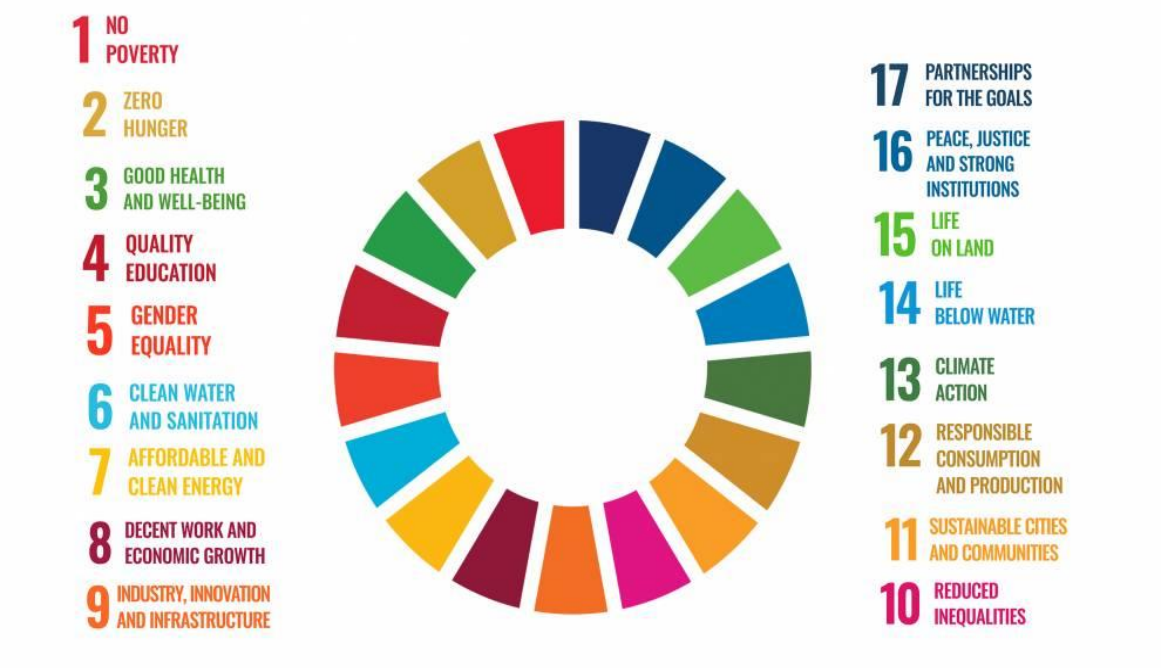


Figure 2. 6: UN Sustainable Development Goals.

Source: University College, London, 2023.

2.2.1 The Sustainability Model

Sustainable development (sustainability) and its component parts can be visualised by more than one model. Thatcher (2013) signifies the three sustainability resources as "pillars" for reinforcing sustainable development in the UN global summit. Sustainable development is recognised as an essential group of ideologies or model (Ponomanreko et al., 2020). Ahmed and Sundaram (2012) considered sustainability as an integrated model of environmental, economic, and social dimensions "of the business scenario". Ten viable characteristics of models which include testability and representation of reality were highlighted by Todorov and Marinova (2011). The study discussed a range of methodological issues related to a sustainability model. Thatcher (2013) graphically (Figure 2.7) presented the "three pillars" hypothesis of sustainability which demands for an equality among the social, economic, and environmental aspects.

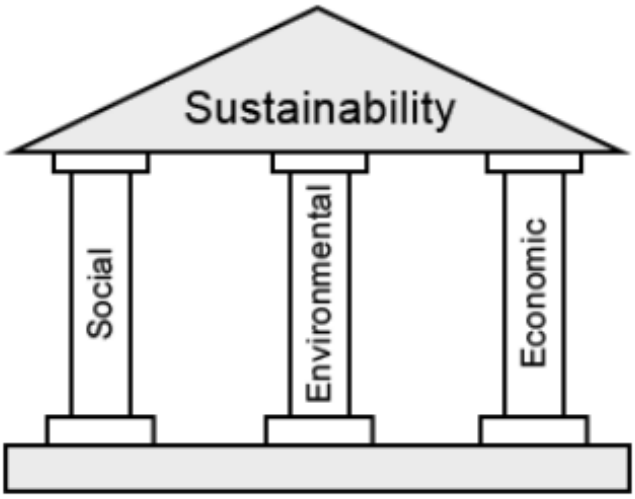


Figure 2. 7: Sustainable Model (TBL)

Source: Thatcher (2013)

The role of politics and technology in section 2.3 and 2.5 (respectively in infrastructure provision and sustainability) requires the further consideration of political and technological sustainability in this context. In addition to this, Jolaoso et al. (2013) considered political will as one of the factors to foster infrastructure development, and Foster et al. (2022) considers the promotion of sustainable technologies when developing infrastructure.

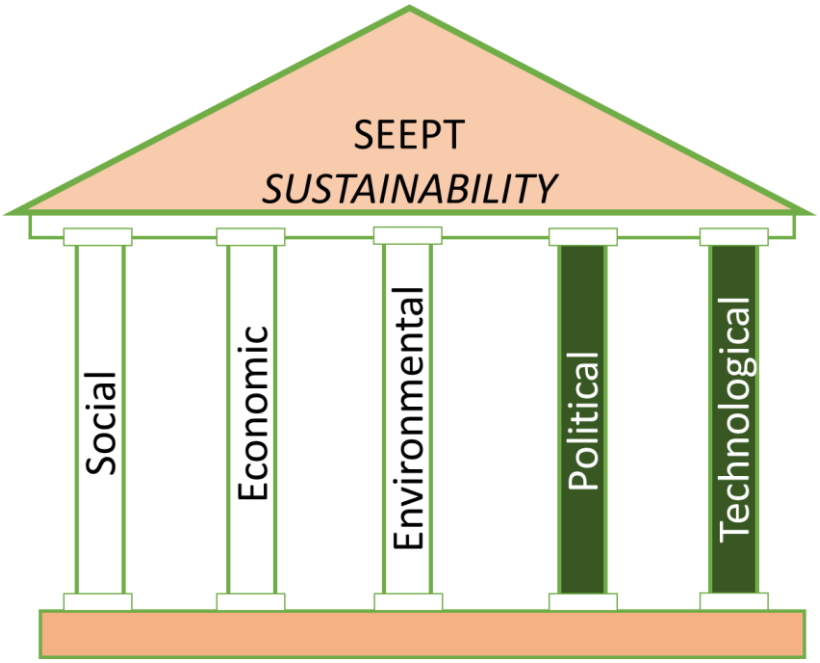


Figure 2. 8: SEEPT Sustainability Model.

Source: Author Generated

The three pillars and two other sustainability attributes (political and technical – considered in the context of this study) hereafter are combined to form SEEPT (Figure 2.8) are further discussed in subsequent sections.

2.2.1.1 Social sustainability

The social dimension of sustainable development is as the name infers, related to the person and human-centered facet of the model. Even though the significance of the human component may seem apparent, there is an irony in the fact that it is possibly the slightest appreciated or concentrated upon facet of the model (Wilson 2013; Missimer 2015; Castro et al. 2022). McGuinn et al. (2020) recognised social sustainability as one the three pillars along with economic sustainability and environmental sustainability.

Fonseca et al. (2019) evaluated diverse definitions of social cohesion from different regions including Canada and Europe. The conclusion was that social cohesion is an imperative concept to humanity that is at the centre of focus on what humankind presently desires. The eventual definition from Fonseca et al. (2019) having strongly considered OECD's definition, is the continuing procedure of developing a sense of belonging, well-being, and charitable social involvement of the members of a society while developing communities that promote and tolerate a diversity of cultures and values.

To ensure the effectiveness of such an approach, cohesion can be measured quantitatively and qualitatively as conducted by IOM (2017) in districts of Antakya, Faith, and Sultanbeyli in Turkey. Thatcher (2013) stated that sustainable development is principally a "social justice project" concentrating on impartial development to satisfy human needs, while still acknowledging that natural resources preservation is imperative to accomplish these needs.

2.2.1.2 Economic sustainability

According to Rakauskiene and Kozlovskij (2014), cohesion as discussed in the economics literature can be construed in diverse ways. Economic cohesion could refer to concepts such as the procedure of convergence between social groups and regions. For others, it could mean social relations and territorial stability, and some could be for preferred living standards and employment opportunities. The economic aspect of sustainability is the economic element of the sustainable development model. It is concerned with, and subsequently measured in, mostly financial terminologies.

In some of the initial conceptualisations of soft infrastructure studied by Turner (2020), this infrastructure is perceived as the fundamental institutional structure that reinforces the management of the social, economic, and political system. This conceptualisation is argued to evolve over time, stressing the role of soft infrastructure as a support for the delivery and operation of hard infrastructure. On the other hand, Cantu (2017) stated that economic activity is promoted through hard infrastructure such as a large physical network. Cantu (2017) continued that economic growth may influence the demand for infrastructure facilities. From the perspective of sustainability, Mendoza and Reathegui (2018) identified the correlation between economic development and economic growth.

Economic growth is the quantitative enhancement of a nation's macroeconomic variables within a specified period and relative to the directly progressing period. It is an expansion in the entire production of services and goods over a certain period. Ojo (2022) argued that it is imperative to concentrate on critical economic infrastructure investment and provision which will, in turn, have associated impacts that enhance other economic segments through environmentally friendly and inclusive programmes and policies.

2.2.1.3 Environmental sustainability

Feroz et al. (2021) considered environmental sustainability as one of the fundamental principles of sustainability which necessitates that gratifying our needs should not compromise environmental quality, and the ecosystem should be sustained for the sake of future generations. As a concept, Brinkman (2020) believed that environmental sustainability can preserve its ability to underpin human life and preserve all existing eco-systems and life into the future despite any depletion of resources via human activity.

Reviewing the population of one of the capital cities (Port Harcourt) in Nigeria which has outnumbered the infrastructure provision, IJSER (2020) observed that abandoned structures have significantly affected the environmental well-being of the inhabitants. The effects of abandoned urban infrastructure in Nigeria on environmental sustainability is immense (Abdul et al. 2018), whereas government in the developed countries encourage the building of sustainable and environmentally friendly infrastructure (Kim et al. 2013).

2.2.1.4 Political sustainability

In implementing a decision-supporting method to structure a strategy of reuse, Vizzarri (2020) considered political sustainability as one of the factors for sustainable recovery intervention. Lockwood (2013) argued that sustainability of policies is dependent on reconfiguration of a political dynamic. It is believed by Scoones (2016) that policies and regulations reconfiguration for sustainability may be perceived to promote modern pathways to development and sustainability, hence, the necessity for sustainability to be embedded in the political perspectives.

In comprehending the reason for the limited progress on enhancing sustainability, Heinrichs and Biermann (2016) described sustainable development as a worldwide political issue. This will further require improvement in political appraisal leading to the design and development of new policy principles. For instance, Nnamseh et al. (2021) suggests that infrastructure provided on political ambition may result in abandonment. This, in essence, would address the negative impact of political power identified by Ogunnusi (2022) as one of the factors contributing to abandonment in Nigeria.

2.2.1.5 Technological Sustainability

Technological sustainability could also be referred to as sustainability of technologies, sustainable technologies, or sustainability of technological processes (Dewulf et al. 2000; Jun 2018) Even though technical sustainability is not among the three original pillars of sustainability, there is a relationship to them (Mukhtar and Saud 2019). With a similar opinion from both Akbari et al. (2020) and Vacchi et al. (2021), the concepts of technology and sustainability (as in the SEEPT model) are related together, essentially, with the meaning of technological sustainability being rarely explored in the context of social and economic sustainability but mainly in the environmental context. Vizzarri (2020) and Pavlovskis (2017) adopted a Technological consideration for redevelopment of abandoned structures.

With sustainability, there is a propensity to consider social, economic, and environmental attributes as independent and separate components (Macchi et al. 2020; and Brink et al. 2020). Furthermore, comprehension of the robust interconnections that link the different components of sustainability enabled by technology is still missing (Vacchi et al. 2021).

2.2.2 Justification for social, economic, environmental, political, and technical (SEEPT) Framework

The social, economic, environment, political and technical (SEEPT) framework is embraced in this study to enhance the sustainability mindset of addressing the issues identified within this research and will frame an objective assessment of their potential impact in the context of infrastructure abandonment. SEEPT is a set of acronyms related to the PESTEL framework. PESTEL which was initially introduced in the eighties by Fahey and Narayaan and has evolved over time with the framework being used in diverse forms such as STEPE by Richardson (2006) and STEEP by Boateng et al. (2015). PESTEL has the flexibility to integrate other methods such as AHP and SWOT analysis, as adopted by Tsangas et al. (2019); Quiceno et al. (2019); and Iheukwumere (2022). SWOT analysis does not have the capacity for evaluation of multiple criteria as noted by Iheukwumere (2020).

The evaluation of identified criteria and alternatives is critical in the context of this study. Hence, with the discussion of the effectiveness of the SEEPT framework, it is considered appropriate to address the problem of infrastructure abandonment.

2.3 Abandonment of Infrastructure in the Nigerian Context.

The welfare of a country depends on functional, appropriate, and readily available infrastructure (Nwannekanma and Gbonegun 2019). Abandoned infrastructure therefore becomes a threat, slowing down the rate of development and causing nuisance to the environment (Abdul et al. 2018). However, Graner (2017) states that abandoned buildings will always be in existence as urban centres never stop advancing and evolving. In other words, technological and social changes will spring further adjustment, and all buildings will potentially lose the initial purpose of their use. This assertion countered the need to consider abandonment as a problem and therefore, in addition, any action identifying a means of mitigating it.

The landscape of Nigeria is littered with abandoned railways, roads, ports etc. at all levels of governance from the federal to the states and local government (Ubani and Ononuju 2013; Olalusi and Otunola, 2012; Oyewobi et al. 2017; Amadi, 2019; Elijah Olusegun and Olumuyiwa 2011).

The number of abandoned infrastructure assets owned by the Federal government of Nigeria (see Table 2.2 & 2.3) reveals how prevalent this problem is and the extent of related missed opportunities. These abandoned infrastructure assets have a potential for positively impacting the economy. Typical examples of abandoned infrastructure turned into lucrative ventures for the public sector around the world include a cotton mill transformed to Puuvilla shopping and services centre in Poland, and the Battersea power plant in London, turned to a mixed used of residential and commercial complex.

Nigeria is seriously losing revenue due to its abandoned properties (Abdul et al. 2018). It would have been expected of a country that is in terrible need of “financial sustainability”, having borrowed to finance infrastructure projects, to have leveraged these government monuments to provide a better life for the citizenry, but these properties are presently rotting away owing to many years of abandonment by the government (Nwannekanma and Gbonegun, 2019). The map of Nigeria in Figure 2.9 shows the location of over 56,000 abandoned projects (The size of the circles does not represent the graphical distribution of the projects).

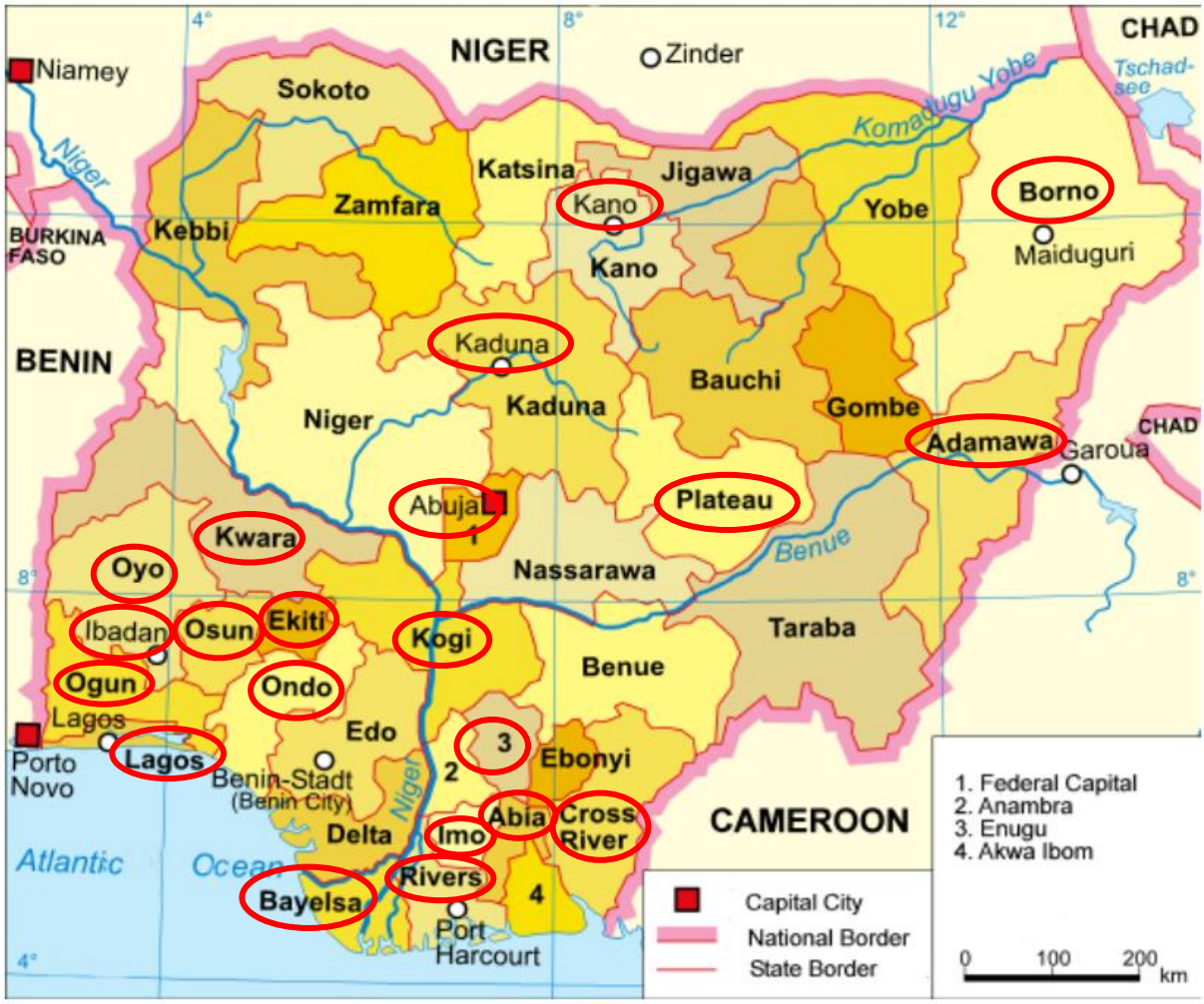


Figure 2. 9 : Map of Nigeria showing 21 states with abandonment based on literature.

Source: Buba et al. (2016), Okereke (2016), Anudu (2019), Oyeleke (2022), Aluko (2023)

Okereke (2016) listed abandoned buildings in different parts of Nigeria, along with suggested mitigation strategies that could be adopted from developed countries (UK, Canada, and USA) to enhance their reactivation.

A further list of some abandoned projects by Federal and some state government is presented in Table 2.2.

Table 2. 2 : Abandoned projects identified across Nigeria

S/N	Type of project	Location	Owner	Year project commenced	Year project was abandoned	Reasons for abandonment
1.	IPP project	Ahoda, Rivers State	Federal Govt	2005	2007	Funds not made available
2.	Bridge	Eagle Island, P/H	Rives State Govt	2000	2006	Due to Change in Govt
3.	Low Cost Housing	Ahoda, east Rivers State	Rives State Govt	2001	2003	Due to Change in Govt
4.	Construction of Link Roads	Orji, Mbeiri, Nwaoruobi to Ugwuorji	Imo State Govt	2009	2011	Political reason/Issue
5.	Road Construction	Alike-Umuosochi-Umulogho	NDDC/Imo State Govt	2011	2011	Problems with the contractor
6.	Road Construction	Ugwunagbo, Umunka road	Abia State Govt	2010	2013	Paucity of funds

Amade et al. (2015); Okereke (2016)

Abandoned infrastructure has adverse effects on society, the economy, and the environment. In the Nigerian context, It is considered a waste of useful resources economically, and also a threat to public health (Scales 2013; Hoe 2013; Tijan and Ajagbe 2016). The abandoned infrastructure assets in Table 2.3 are also hideouts for criminal activities (Muzenda, 2018). According to the assertion by Elijah and Olumuyiwa (2011) and Okafor et.al.(2018), Nigeria had become the "world's junk-yard" of abandoned and failed projects, worth an estimated 300 billion Naira (about £6.3 Million). Unfortunately, this number has increased to 56,000 projects worth N17 trillion (£28,757,625,510) "and still counting" (Ibunge 2023).

Hanachor (2012) pointed out that some of these projects in the community are not meeting the needs of the community and were probably conceived by political ambitions which led to their abandonment. This could also be considered a case of gold plating and/or pork-barreling. Connolly (2020) defines pork barreling as the disbursement of public funds to voting members for political reasons. Pork-barrel projects are projects that are financed with a country's tax incomes to benefit a localized population (Klingensmith 2016; and Klingensmith 2019).
Najjar and Jarbi (2016) considered gold plating as an unexpected change in scope, thereby suggesting that the pork-barreling concept is the more appropriate one to the abandonment situation. Projects embarked upon against the cultural practices and norms of the society/public as pointed by Hanachor (2012) could also become abandoned. Projects mentioned by Hanachor (2012) include those executed by the government without any contribution to decision making from the community but enforced on the community. Table 2.3 lists some of the abandoned infrastructure identified by some authors:

Table 2. 3 : Additional examples of abandoned infrastructure in Nigeria

Authors	**Abandoned Infrastructure Description**
(Muzenda 2018)	Federal Ministries of Works and Housing, The National Stadium complex, Federal Secretariat Complex, National Assembly Complex, Ministry of Defense and Ministry of Education buildings.
Ubani and Ononuju (2013)	With the movement of government seat from Lagos to Federal Capital Territory, Abuja, over 60 buildings belonging to the Federal government are abandoned and subsequently become dilapidated

Okafor et.al (2018); Elijah and Olumuyiwa, (2011); Daniel and Ibrahim, (2019)	4000 abandoned Federal Government projects in Nigeria at an estimated cost of about N300 billion (about 6.3M Pounds).
(Muzenda, 2018)	N126.2 billion (about 214 million pounds) was recounted as the value of the abandoned infrastructure belonging to Federal Government of Nigeria in Lagos State (SW Nigeria) alone
(Alao et al. 2019) (Odutola and Adeniran 2017)	Over N3 Trillion (about 5.1billion pounds) worth of abandoned infrastructure projects are also attribute to 10 states of the nation since 2012 and yet to be accounted for by the sitting government. For instance, 10-lane Abeokuta Sagamu interchange road projects, 27 General hospitals across Imo state, N20 Million (about 34,000pounds) two units blocks of three classrooms in Kano states, abandoned public tertiary education institution building in Osun State
(Okereke 2017)	Former President Goodluck Jonathan instituted the Abandoned Projects Audit Commission (APAC) in 2011. From the report of APAC, 11,886 projects belonging to the Nigerian federal government were abandoned in over a period of four decades from 1971 to 2011.

Other causes of abandoned infrastructure as highlighted are listed in Table 2.4:

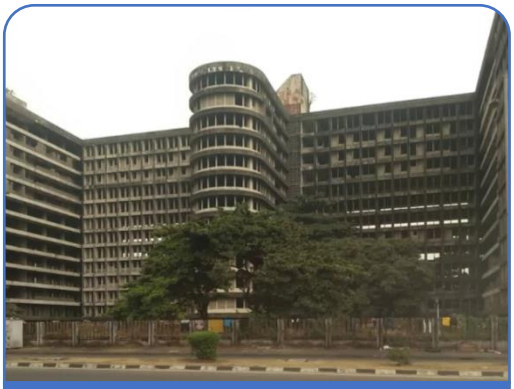
Table 2. 4 : Causes of project abandonment deduced from literature

Authors	Factors
(Ubani and Ononuju 2013)	Misappropriation of projects finances Means of payment and financing of completed projects. Recurrent changes in political power and government Deficiency in technological capability Inability to detect warning signs of issues on time.
(Olalusi and Otunola 2012)	Inefficient payment plans Corruption and politics Method of **procurement** Prequalification processes
(Elijah Olusegun and Olumuyiwa Michael 2011)	Insufficient funding, ineffective planning, inflation, contractor's bankruptcy, project scope variation, "political factor," client's death, payment delays, erroneous estimate, defective design, ineffective cost control

(Amade *et al.* 2015)	- "Political risk" -Inefficient understanding and monitoring of the mission of the project -Inefficient information and communication management by the design team -Project manager's technical knowhow -Inefficient **Procurement** Process -fallout of failure from cost overruns and low-quality pivots
(Oyewobi et. al. 2017)	**Procurement** systems
(Dim and Ezeabasili 2015)	Ignorance to adopting and implementing modern **procurement** strategy
(Adetola et.al 2011)	Traditional forms of projects **procurement**
(Ezenekwe and Uzonwanne 2017)	Uncertainty to adopting and implementing modern **procurement** strategy
(Okafor et.al. 2018)	Defective **procurement** procedures, non-functional government policies, defective design, incompetent contractors
Olumide et al.(2018);	Inadequate allocation of funds, inefficient project planning and scheduling, corruption, inconsistent government policies, lack of stakeholders' involvement, natural disaster, incompetent project management, payment delays, ineffective project estimation, planning inadequacies, gaps in communication among personnel.

From the literature reviewed and the summary in Table 2.4, design issues, politics and policies, lack of monitoring, communication and information management, insufficient funding, and procurement (appearing seven times) have all been mentioned as the main reasons for abandonment. With procurement ranking high as one of the reasons for abandonment, integration of sustainability (embracing the triple bottom line – economic, social, environment) into the existing procurement procedures in Nigeria is important (Oyewobi et al. 2017). Some of the buildings abandoned in different parts of Nigeria are pictured in Figure 2.10.

Abandoned Federal Government buildings in Lagos are now homes to miscreants and robbers | Pulse Nigeria



Abandoned Federal Secretariat, Lagos State, Nigeria

Figure 2. 10 : Abandoned buildings in Nigeria.

Source: Wahab 2020 and Ayeyemi (2021)

2.3.1 Impact of Abandoned Infrastructure on Nigerian Economy, Environment and Society.

Ayeyemi (2021) and Damoah et al. (2020) claimed that the impact of abandoned infrastructure on the economy cannot be overlooked as this is becoming a major cause of concern. Atamewan (2020) studied the environmental and socio-economic implications of abandonment in Nigeria and presented the outcome of an insecure, unhealthy economy which would be a threat to the sustainability of the built environment. Impact of abandonment as identified by Olumide Odeyinka (2018); Scales (2013); Hoe (2013); Tijan and Ajagbe (2016); Amade et al. (2015) comprised an increase in unemployment and other social vices, traffic, delays, marred environmental aesthetics, threat to public health, economic value deficit, and waste of material and financial resources.

Garba (2019) identified the effect of abandoned buildings on the economy stating the negative impact on government taxes causing reduction of budget for services such as the provision for police and fire services, reduction in the measurement of economic activities, and reduction in accrued revenue to the government and a lowered standard of living. These pose adverse effects on socio-economic activities resulting in lower property values within the neighbourhoods (Buitelaar et al. 2021). Odutola and Adeniran (2017) also asserts that abandonment poses a series of negative effects which have been identified by scholars and financial and environmental analysts in Nigeria. For instance, the given foreign exchange devaluation between 2013 (₦150/$1) and 2017 (₦550/$1), a project abandoned during that period can accrue a multiple fold increase in cost at completion, thereby increasing the probability that it will remain abandoned. The projects that were once commemorated are now considered ‘white elephant’ projects such as Millennium Tower in Abuja (Oyoyo 2021). Further impacts of abandoned infrastructure are highlighted in Table 2.5.

Table 2. 5: Socio - economic impact of abandoned infrastructure

Authors	Impact	Keywords
(Olalusi and Otunola 2012)	Housing shortage, Defacing the aesthetic, or reducing the beauty, spread of disease, threat to the environment	Housing shortage
(Woka and Miebaka 2014)	Negative impact on real estate value, reduced motivation to attracting investment in real estate properties, waste of material and financial resources, reduction in expected income from property tax	Value for money
(Hoe, 2013)	Depleted Government Reserve, pollution, and noise,	
(Mac-Barango 2017)	Wastage or resources, decrease decline in employment prospects, decrease in cadence of construction activities, reduction in accruable revenue to the government, hide-out and accommodation for hoodlums, street boys and armed robbers' gang, unpleasant appearance, general eye-score to the environment	Wastage, Insecurity
(Ezenekwe and Uzonwanne 2017)	(Road) Vehicles destruction, Armed robbery, Waste of resources, decrease in employment opportunities, Environmental pollution, Loss of Lives, low quality of living standards, reduction in cadence of construction activities, loss of properties.	Low living standard
(Tijan and Ajagbe 2016)	(10) Negative impacts, loss of strength of structural components, hideout for perilous animals, visual defects to project site and surroundings, loss of economic value of the vicinity/area, population marginalization, Carrero et.al (2009) states visual impact to be erosion, pollution, decrease in biodiversity, landscape modification (ii) Socio- Economic impact are rise in unemployment, population marginalization, conflict between private sector and public administration, loss of economic value of the vicinity. Efenudu (2010) reduction in property value within the locality, waste of material and financial resources, rise in unemployment	Visual defects and loss of economic value
(Akogun 2014)	Bushy environment, unappealing view, adolescent dating places and hangout, robbery and stealing cases, mosquitoes breeding issues, marketability difficulty, the risk of unexpected collapse of derelict walls, abode for perilous animals such as insects and snakes.	Criminal activities and health threat
(Elijah Olusegun and Olumuyiwa Michael 2011)	Identified the inability of the government to realise expected income from property tax	Reduction in revenue
(Ubani and Ononuju 2013)	Dilapidation of the environment, immense waste of scarce resources, unemployment, flood, deterioration and degeneration of road and other infrastructure,	Deterioration and regeneration of resources
(Elijah Olusegun and Olumuyiwa Michael 2011)	Dissatisfaction of the users/populace, waste of resources, low living standard, low tempo of construction, decrease in employment opportunities, complexity in attracting foreign loan, reduction in government revenue	Low living standard
(Okafor, Osadebe and	Abandonment possesses negative impact on the environment and general populace. The authors considered abandonment	Waste of useful resources

Sylvester 2018)	as a means of the resources being wasted away without being of any benefit to the population. Abandonment also signifies the waste of national resources and public funds. The author stressed the "cycle of abandoned projects" claiming that project commenced by previous government are abandoned at the appearance of a new government in power and a new one with no assurance of completion commenced. Moreso, the mental, social, physical, economic health and well-being of communities, family and individuals are being unpleasantly affected owing to the abandonment
(Doraisamy et al. 2015)	An unbearable issue to the industry, economy, and states

The problem of abandoned buildings is yet to be resolved and they have a ripple effect on the whole economy of the nation, and the construction industry specifically (Doraisamy et al. 2015; Nsiah - Asamoah). Damoah et al. (2020) affirmed that the construction industry of every nation propels economic advancement as it functions as the underpinning for other sectors' advancement. For instance, in spite of stable development experienced over the years in Russia's economy, Khaertdinova et al. (2021) argued that Russia's construction industry has recently experienced economic instability. Hence, the necessity to manage projects effectively in the construction industry cannot be exaggerated.

2.3.2 Abandonment in other Nations

Okereke (2017) explored the causes of abandoned projects (such as haphazard management and corruption in Ghana, poor planning in Egypt, fund mismanagement in South Africa, and poor supervision in Nigeria) and concluded that abandoned projects are not strange to citizens of developing countries. Damoah et al. (2020) investigated the consequences of abandoned government construction projects on stakeholders in a developing economy with particular attention on Ghana. The study highlighted 17 effects which include "bad image for the government, stunted economic growth, pollution". According to Hoe (2013), abandonment of projects is one of the problems hounding Malaysia's construction industry. The construction projects abandoned have developed into several consequences that have adverse impacts to society, economy, and the environment. It is also considered a waste of useful resources.

The after-effects of abandoned projects are wide-ranging. Olalusi and Otunola (2012) stated that project abandonment is not limited to developing nations alone. Developed countries also have examples of abandoned infrastructure as this is a global problem. Wallace and Schalliol (2015) further related abandoned projects to social disorder by demonstrating the severity and the presence of social disorder and crime in Chicago. Amade et al. (2015)'s insight (in Section 1.5), also linked abandoned and vacant structures reported to an increase in crime. Abandoned structures can present considerable challenges to the safety and health of communities in China (Kondo et al. 2015).

Two public buildings - The Khutsong Clinic and the Carlton Hotel - were some of the infrastructure abandoned in South Africa (Fuchs 2021; Wood 2021). With the dearth of capability during project execution, and inability to manage service providers, possibly leading to overruns and delays, Emuze and Kadangwe, (2014) discovered that some of these challenges contribute towards abandonment of road projects in Malawi and concluded that general training / management skills (such as artisans and technicians), relevant to the mitigation of the abandonment problem should be considered.

2.3.3 Infrastructure procurement and other causes of abandonment

The procurement system is one of the major causes of abandonment of infrastructure as indicated in Section 2.3, Table 2.4. According to Manu et al. (2019), achieving sustainable development goals is associated to public Infrastructure procurement in a way that connects important procurement goals such as sustainability, accountability, transparency and value-for-money (Manu et al. 2019).

Considering the definition of procurement as being acquisition of goods and service, procurement can be the acquisition of a simple element, a phase of a project or complex acquisition of "*multiyear international construction contracts"* (Project Management Institute 2017).

The Royal Institution of Chartered Surveyors (RICS 2014) considers procurement as the act of acquiring services and goods from external vendors, including the strategic decision on the acquisition of the goods by assessing the requirement of the client. Manu et al. (2019) highlights the inadequacy in quality and quantity of infrastructure procurement in Nigeria which covers housing, power generation infrastructure, health, water, sanitation, and transportation. This inadequacy has further resulted in public procurement challenges such as inefficient tender boards, financing issues and deficiency in procurement capacity.

With several definitions of procurement from authors, including Ibem et al. (2017) and Nijaki and Worrel (2012), in combination with the consideration of the effective "Sustainable Procurement Policy" (Section 2.1.4), this study adopted the procurement definition of Ruparthna and Hewage; PMBOK cited by Loosemore, (2016):

Procurement is the process employed by organisations to acquire products and services needed for their objectives accomplishment at the optimum quality, cost and timing in a manner that does not damage the society or environment.

Walker and Brammer (2012) and Eagle et al. (2020) asserted that the role of government purchases as a stimulus for sustainable development is a topic of interest in the public sector. Nevertheless, Oyewobi et al. (2017) review of the current Nigerian Public Procurement Act 2007 shows no emphasis on sustainability. Ruparathna and Hewage (2015) also agreed with the complexity of processes of construction procurement which has a considerable number of accessible directions and options. A provisional interim statistic, as noted by Ruparathna and Hewage (2015) reveals that procurement is becoming integrated with contemporary initiatives such as life cycle, standardisation, and sustainability.

Studies such as Dim and Ezeabasili (2015); Deloitte (2015); Duffet and Wakeham (2023) identified public sector procurement as a feasible and attractive mechanism that influences the market structure, ascertains the level of social and economic advancement in the country and determines the responses of the supply sector in an economy. However, the prevailing approach of procuring public projects in Nigeria, which is a traditional procurement system, is less effective (Dim and Ezeabasili 2015). Alternative approaches such as design & build, construction and project management, and the contracting method are set up to accomplish timely delivery of a project within a budget allocation. Moreso, the traditional approach has been criticised by Dim and Ezeabasili (2015) for the consideration of the design and construction procedures as separate entities, which is not the case with a non-traditional procurement method such as design and build, construction project management, and management contracting method of procurement.

The inefficiency in the procurement system in Nigeria contributed to the upsurge in abandoned government buildings scattered across the country (Oyewobi et al. 2017) and also the public sector procurement system is deficient in sustainability ideals both in strategies and concepts. This heightens the necessity to incorporate sustainability concerns into public infrastructure procurement in Nigeria.

In fact, many developed nations such as Austria, Spain, Sweden, and the United Kingdom have taken the front baton after the call on governments, globally by the "World Summit on Sustainable Development" in 2002 (Lafortune et al. 2020). In addition to UK's effort towards sustainable procurement practices as mentioned in Section 2.1.4, Sweden also developed policies focusing on interaction between procurement practices and policy ambitions in infrastructure construction (Lingegard 2021; Thacker et al. 2019).

The UK policy (Government, 2022) on appropriate government guidance in construction against abandonment is notable. This is obvious in the continuous roll out of policies and regulations which include 'The Construction Playbook' and also the environmental improvement in the infrastructure industry through the low carbon agenda (Lingegard et al. 2022). An HM Government document laid emphasis on good construction practices including the 'guidance on sourcing and contracting public works, projects, and programmes. Similar policies such as sustainability and carbon reduction plan within the Construction Playbook can be adopted by Nigeria's government to address abandonment.

Another comparative analysis of UK and Nigeria is the consideration of the concept of "*abandonment*" to mitigate risk. For instance, during the national infrastructure assessment, the National Infrastructure Commission (NIC) in UK appraised infrastructure development and identified the possible occurrence of abandonment through natural occurrence (e.g flood) with management procedure implemented to mitigate such occurrences. In comparison, there was no mention of abandonment at all in the Infrastructure Concession Regulatory Commission (ICRC) - Act 2005 of Nigeria (NIC 2018; ICRC 2005). Can this be a case of neglect or poor planning in the case of Nigeria government or both? Planning is one of the phases of construction projects (Omotayo et al. 2018).

Public sector procurements can contribute to the enhancement of sustainable development all over the world and constitute an important component of the national economies in various nations (AlNuaimi and Khan 2019). Some public organisations are either applying procurement regulations for developing the economy or for preserving the environment (Nijaki and Worrel 2012). In other words, government establishment at different governing levels forms the main body procuring infrastructure projects globally. Table 2.6 presents a comparison of public infrastructure procurement between Nigeria and United Kingdom.

Table 2. 6 : Comparison of procurement between Nigeria and developed nations

S/N	Description	Nigeria	UK
1	Current Public Procurement Policy	Public Procurement Act of 2007 (Oyewobi et al. 2017)	Public Contracts Regulations 2015(Subject to EU/Brexit) (UK Government 2015)
2	Sustainability	No emphasis on sustainable procurement even in the PP Act 2007 (Oyewobi et al. 2017)	Significant progress on sustainable procurement since 2005 (Walker and Brammer 2009)
3	Net worth of infrastructure per GDP	(Oyewobi et al. 2017)	6.7% Growth expectation by 2023 is 9% (Hanachor 2012) (Chris 2019)

Procurement plays a crucial role in the activity of any establishment, including public organisations. Public sector procurement could be impacted by political considerations (Shaw 2010) and could be steered by factors such as ethics and value for money, transparency, and accountability for the taxpayers and citizens. It can also be a pedestal for delivering government's broader objectives by expending public funds to promote social and environmental objectives (Walker and Brammer 2009). There is a need for Nigeria to take a cue from the UK's efforts to be among the leaders on sustainable procurement in response to the goals at the World Summit on Sustainable Development in 2002. Implementing Greening Government Commitments as a 2016 -2020 policy and the publication of Construction Playbook are some of the feats recorded by the UK government till date in this regard (Bond 2019). Recent development from Tonybee (2023) indicates that UK is going backwards in this respect.

2.3.4 Redevelopment of Abandoned Infrastructure in Other Countries

Abandoned buildings are a pressing issue that necessitates urgent interventions, while maximising the value of limited resources (Buitelaar 2021). Although it can be argued that there could be a level at which abandonment can be tolerated, through serving purposes even in a derelict state. For example, Projekt Interim in Switzerland is an organisation that manages temporary use and rental of abandoned buildings for business start-ups, living accommodation and pop-up shops (Anderson and Hamilton 2019).

As emphasised in Section 2.0, one of the purposes of this research is to make a case for the Nigerian government to consider the array of abandoned infrastructure and their sustainability (Ogunnusi et al. 2023). As practiced in some of the developed nations such as United Kingdom and United States of America, government are innovatively repurposing abandoned infrastructure to meet the current and future needs of generations to come. For instance, Priest (2019) recognised the conversion of the Battersea power plant in South London, the site being derelict since 1982, into a mixed purpose use by a group of architects including Wilkinson Eyre, Rafael Vinoly, Frank Gehry and Foster + Partners, while in Korea, Boo and Kwon (2018) investigated the opportunities "for the sustainability of abandoned infrastructure" through the modification of Seoul Station Overpass, built in 1970, to an Urban Park. Ten abandoned cinemas were also recovered in Italy, refurbished and converted to student accommodation (Cascone and Sciuto 2018).

Additionally, Araszkiewicz (2016) highlighted the transformation of a Polish government owned large cotton mill into the Puuvilla Shopping mall, accommodating educational activities, office spaces, cultural events, retailing for high-quality facilities and other government functions. Zhang et.al (2020) also argued that the reuse of abandoned railways in China will underpin the rebuilding of urban public transport, in essence, leading to urban regeneration of their immediate neighborhood.

A good example of Zhang et al. (2020) suggestion is the conversion of part of the 43.5km Old Dee Side Rail Line (1853-1966) (Figure 2.11) to a cycling, walking and horse riding route by Aberdeen City Council.

The remodeling of the Polish cotton mill was made possible with the use of green BIM -Laser scanning (See Section 2.5). Hence, Olawumi (2020) reinforced the necessity to explore a green BIM (gBIM) initiative in construction projects and to also provide evidential support for clients and project teams in Nigeria. Although gBIM can help with enhanced decision making, as noted by Bynum et al. (2013) and Azhar et al. (2011), this is only at the initial stage of the project. With these, gBIM may not be applicable to completely solve abandonment in Nigeria without further development.

Ismail et al. (2019) defined gBIM as a sustainable procedure mainly to preserve the building industry' activities to provide minimum impacts concerning their environment and surroundings through the deployment of Building Information Modelling, while Srivastava and Parvez (2021) simply defined gBIM as a relationship between project phases, Green Attributes and BIM attributes. Likewise, Ogunnusi et al. (2022) adopted the study of a multiple Rs concept comprising of 5Rs - rethink, reduce, reuse, refurbish and regulation in addressing abandoned infrastructure in Nigeria. Traditionally, multiple Rs concepts consists of 3Rs - reduce, reuse, recycle which are being considered as alternatives for products waste management.

Figure 2. 11 : Old Dee line converted to cycling, walking and jogging lane.

Source – (Ogunnusi 2020)

2.4 Public Buildings

Public buildings are examples of hard infrastructure (Section 2.1.1) (Sanda et al. 2016). *Designing Buildings* (2020) presented the EU countries' definition of public buildings as buildings that are non-apartments and non-residential, provide public services, are procured and occupied by government bodies. Chidi et al (2019) asserted that public office buildings globally provide accommodation to a sizeable number of staff who work for the interest of the public. These public buildings include "schools, hospitals, government offices, police stations, fire stations, postal offices, prison systems, parking structures" as noted by Uddin et al. (2013) and Cirrincione et al. (2022).

Morgan et al. (2018) stated that public buildings are designed, operated, and maintained to offer service and shelter to satisfy the need of users. They are utilised by members of the public for any intention such as assembly and so on (Ogunbayo et al. 2022). Like Canada's public building

infrastructure, they could also age and significantly depreciate as studied by Ruparathna et al. (2017). Akande (2021) and Adeyemi et al. (2017b) discussed the Federal Secretariat buildings in Nigeria. From the findings, Akande (2021) expressed concern about the negative impacts of the abandonment of these buildings, while Adeyemi et al. (2017b) investigated how best can public office buildings be sustainably improved in Nigeria from an end users' perspective using Lean Thinking. The Lean thinking study was focused on the existing users' assessment of the building which contrasts with the study of a vacated abandoned public office building within the context of this study (Section 1.0). Nonetheless, for future studies, lean thinking may be considered for improvement of a building after its successful redevelopment and occupation.

2.5 Innovation tools for redevelopment of abandoned infrastructure

Interestingly, some literature identifying abandoned infrastructure problems suggests the use of innovative technology such as Building Information Models (BIM), as discussed by Volk et al. (2014). Some of the publications suggesting the innovative tools and refurbishment of abandoned infrastructure include:

- Cascone and Sciuto (2018) recommended the application of Building Information Modelling to future studies in the retrofitting for the spatial, geometric and information of the performance of the building all in 3D' models.
- Tan et al. (2021) identified sustainability as one of the five key application domains of combining BIM and Multi Criteria Decision Making (MCDM) from the systematic review conducted. Pavlovskis et al. (2017) proposed the combination of MCDM (with the application of criteria systems and ranking of alternatives) and Building Information Modelling (BIM) for the redevelopment of abandoned buildings.
- Araszkiewicz (2016) stated the application of gBIM and Laser Scanning in the remodeling of the big cotton mill into Puuvilla Shopping Mall in Poland.
- Cheshire (2017) demonstrated the University of California, Los Angeles (UCLA) professor Greg Lynn's application of BIM for the redesigning of the abandoned Packard Plant in Detroit in 2016 Venice Biennale in the US Pavilion.
- Infrastructure BIM (I-BIM), although not directly utilised for abandoned structure, could be considered in this context as adopted by Fabozzi et al. (2021) and Biancardo et al. (2023) for transport infrastructure study.

The use of BIM, gBIM and Laser Scanning, as highlighted in the literature listed above, pointed at a different direction to be considered for the refurbishment, remodeling, retrofitting or revamping of abandoned infrastructure as highlighted by Amade et al. (2015) Ubani and Ononuju (2013) and Olalusi and Otunola (2012). Among the many applications of Laser Scanning, it can be used to retrieve the as-built information on site as highlighted by Ding et al. (2014); Tapponi et al. (2015); Olanrewaju (2021) and is also applicable in addressing the issues of abandoned infrastructure where base drawings are usually no longer available.

Establishing a BIM model for an existing structure can be difficult and time consuming to undertake as identified by (Raza 2017). In fact, Macher et al. (2017) considered the modelling of an existing buildings indoor areas to be a 'huge issue' ever since the advent of BIM in the AEC industry, which

requires the capturing of the 'as-is' condition of the building. Macher also sees the process as time consuming and requiring specific proficiencies. Focusing on a recognised BIM subset, Lopez et al. (2018) also supported the time-consuming challenges identified by Raza due to the irregularity and complexity of the historical buildings' shapes. Despite the complicated application of BIM, viewing the benefits, Pogorelskiy and Alava (2018) affirmed that existing buildings can be redeveloped to generate the building digital representation, incorporating the valuable information for further maintenance, renovation, and operation. According to Liu et al. (2022), BIM-centered technologies can be applied to the evaluation of existing buildings or retrofit solutions, Digital Twin, hence, enabling the net-zero-energy buildings development.

Several scholars such as Abdul et al. (2018), Atamewan (2020), Akande et al. (2021), Nnamseh et al. (2021), Ekele et al. (2022) have made efforts at proffering a solution to curb the occurrences of abandoned infrastructure projects, but the problem persists (Philip et al. 2012; Hoe 2013). Perhaps, the problem could be a lack of interest by government. The situation may remain unresolved unless the government decides to adopt a different perspective on the problem.

Sustainable development of abandoned infrastructure will often pose, to policy makers and government, several questions around what may constitute a sustainable development (Bianchi and Medici 2023). Decision makers will often be faced with several re-development options and underpinning interests and objectives that must be factored into such decisions (Ministry of Defence 2016). Sometimes, the array of available options may be overwhelming and sometimes conflicting for decision makers (Bris et al. 2019; Hodkinson 2019). In addition to the innovative tools listed above, decision makers will benefit from systematic approaches that recognises the different alternative solutions and the different interests (decision criteria) in coming to key decisions about what to do with an abandoned infrastructure. There are several decision tools available (Table 2.7).

Table 2. 7 : Decision tools obtained from Martin (2023)

N	Tool	Description	References
1	Swot diagram	A SWOT analysis refers to the evaluation and assessment of diverse strength (S), weaknesses (W), opportunities (O), threats (T) and other considerations that impact a particular topic. Define and identify problem areas within an organisation. It can be costly and time consuming.	Zhou et al. (2021) Duncan (2023)
2	Pareto Analysis	This concept that originated with Vilfredo Pareto (1848 – 1923) is a statistical technique, applied in decision making for selection of constrained number of tasks that creäte significant overall effect.	Denning (2012) Rimantho et al. (2016)
3	Break -even analysis	This is applied to identify the break-even point, that is, the point where a company has incurred all cost with no profit	Pandi (2017)
4	Ratio analysis	Ratio analysis is utilised to establish the financial soundness of business concern	Periasamy (2010)
5	Decision Matrix	Decision matrix techniques are applied to define attributes, weigh them, and properly compute the weighted attributes to provide a relative ranking among alternatives. The decision matrix comprises of columns and rows that permit the evaluation of diverse decision criteria relative to alternatives	Chang (2015)

From the list of decision tools in Table 2.7, Decision Matrix exhibited the evaluation of criteria and alternatives relating to Pavlovskis et al. (2017) MCDM study in section 2.5 on abandoned building redevelopment. In this regard, the next section presents the evaluation of MCDM in the context of this study.

2.6 Multi-Criteria Decision Making

According to Ghosh and Das (2013), a Multi-Criteria Decision-Making issue is usually expressed in a matrix format termed as a 'decision matrix' (Table 2.7). Fazeli et al. (2019) states Multi-Criteria Decision Making (MCDM) is a fundamental approach in the decision-making process which demonstrates decision challenges. As earlier stated, the subject of the decision-making must be distinctly comprehended at the outset. For instance, Erdogan et al. (2019) applied MCDM for the selection of a suitable construction method and an appropriate contractor. Erdogan states that the underpinnings of modern MCDM were developed in the 1950s and 1960s.

Balioti et al. (2018) viewed MCDM as a sophisticated decision-making tool relating to both qualitative and quantitative components. Diverse MCDM approaches, and techniques have been recommended for selection of the optimum solution. Anastasiu (2018) presented the development of the decision-making process by aligning the applicable selected criteria interrelated to alternatives. Rohmatulloh and Winarni (2014) identified MCDM as a method that is recurrently applied to solve a decision-making issue with many attributes and criteria. Erdogan et al. (2017); Ojokoh and Afolayan (2018); Wang et al. (2020); and Gebre et al. (2021) specifically identify the context in which MCDM can be considered usually in the presence of typically conflicting, multiple criteria and alternatives.

Throughout the literature review to this stage, one of the major observations has been with regards to the redevelopment of abandoned infrastructure in Nigeria within the prerequisites of a sustainability driven method. This directs the review into the sphere of decision making. Kabir and Hasin (2012), Pavlovskis et al. (2017), and Vizzarri (2020) amongst other authors, provided a platform for possible and relevant criteria and alternatives to be considered in the context of this study. With the SEEPT sustainability (five attributes) as discussed in section 2.2.1-5, this set of attributes (environmental, economic, and technological) were adapted from Pavlovskis et al. (2017), while political and social attributes were adapted from Vizzarri (2020) and Mcguinn et al. (2020) respectively. The four alternatives which includes refurbishment, conversion, demolition, and partial/outright selling were obtained from different literature as presented in the subsequent sections.

Nevertheless, the work in this chapter is not to develop or design a decision-making model, but to develop and explore questions which will enhance the focus to be maximised and retained on the subject field. In this regard, it is essential to appreciate the principal mechanism of the discipline in this situation. The next section will develop the criteria and alternatives for sustainable redevelopment in the context of the abandonment problem.

2.6.1 Review the alternatives and criteria.

The literature review for this study commenced with generic ideology of causes of abandoned infrastructure with possible solutions to address the problems. However, further literature review commencing with Pavlovskis (2017) presented the need for evaluation with sustainability mindset as stated in Section 2.5 (sustainability for new and existing), Pavlovskis (2017); and Ilter and Ergen (2015) further highlighted the emphasis on sustainability for redevelopment of an abandoned building with the identification of a particular case study. Meanwhile alternative redevelopment solutions were also first cited by Zavadskas and Antucheviciene (2008); and Siozinyte et al. (2014) with Pavlovskis further breaking down the sustainability mindset into Environmental, Technology and Economic.

Vassoney (2021); and Aziz et al. (2016) identify MCDM as a compilation of techniques with the complete goal to establish an organisation of preference among alternative evaluation possibilities, with performance scored against several criteria. Criteria are tools for evaluating and comparing alternatives from the perspective of the outcomes of their selection (Taherdoost and Madanchian 2023).

Mardani et al. (2015) claimed that most of the approaches deal with distinct alternatives which are depicted by a set of criteria. From the study, Mardani et al. (2015), further identified for a particular problem, diverse methods can be proposed which cannot be applicable to other problems. Mardani et al. (2015) asserted that a decision can be made on diverse criteria, by allocating weights to various criteria with the weights obtainable from expert groups. On the other hand, Gebre et al. (2021) identified alternatives as being diverse choices that are obtainable to the decision maker.

The selection of the criteria and alternatives are based on a literature review, as shown in Table 2.8. The alternatives and the criteria were evaluated against a case study in Chapter 3. According to Coombs (2022), a case study is a methodological study approach utilised to produce an in-depth comprehension of a phenomenon or a contemporary issue in a bounded system. However, the case study definition within this context will be adapted from Stepien (2019) as "an in-depth exploration from multiple perspectives of the uniqueness of a particular policy, "*project"*, programme, institution, or system in a "*real-life"* context.

Table 2. 8 : The ten (10) criteria for sustainable redevelopment alternatives *(in italics)*

N	Criteria		Country
C1	Pavlovskis et al. (2017) considered *Project preparation and coordination* under technological attributes. Project coordination of actions on a project enhances the effective implementation of the project (Lapidus et al. 2022). Asiedu and Adaku (2019) mentioned ineffective project preparation and coordination as one of the major causes of cost overrun leading to abandonment as noted by Emuze and Kadangwe, (2014)	*Project preparation and coordination*	Lithuania
C2	With expert perception into social sustainability concept and the means of addressing it in legislation and policy making, Mcguinn et al. (2020) identified *creation of employment* as one of the main determinants for social sustainability. Scarpetta and Pierre (2015) affirmed that employment creation is frequently at the peak of the advancement agenda for civil society and policy makers.	*Creation of employment*	Luxembourg
C3	According to Aboulnaga (2014), the conception and demonstration of energy efficient buildings is gaining ground. An *energy efficient* construction generates comfortable living conditions with the minimum likely amount of energy consumption while maximizing the efficient use of resources (Gupta and Chakraborty. 2021)	*Energy efficient*	India

C4	To curb and manage these *waste generation*, a complete understanding of issues around the waste generation in construction is essential (Luangcharoenrat et al. 2019). Ogunnusi et al. (2022) argued that the negative impact of abandoned infrastructure is the waste of financial resources.	*Waste generation*	Thailand
C5	Pavlovskis et al. (2017) considered *preservation of historical value* as one of the key aspects of sustainable redevelopment consideration of infrastructure. Croatto et al. (2017) also asserts that preserving the historical value of buildings bears evidence of twentieth -century construction.	*Preservation of historical value*	Lithuania
C6	Ahmad et al. (2012) critically evaluated the relationship between investment and economic growth. *Investment* expenditure creates direct contribution to economic activity as the most unpredictable component of GDP. McIntosh et al (2018) investigation presents that investing in infrastructure produce further investments at the neighbourhood level, resulting in advanced social outcomes. In other words, stagnations in infrastructure investment correspond with slower productivity development, even in developing countries (World Bank 2020; Han et al. 2020).	*Investment*	Pakistan
C7	*Profitability* is the achievement of an organisation or an entity base of financial performance (Fatihudin et al. 2018). However, Phan et al. (2020) asserts that sustainable development practices have become very imperative beyond short term profitability towards social, environmental, and economic sustainability.	*Profitability*	Indonesia
C8	The building lifetime in Pavlovskis et al. (2017) was changed to *Structural Integrity and Foundation*. This is also part of the technological criteria with the intention of evaluating the structural stability of the projects. According to Trampus (2014), structural integrity revolves around the evaluation of resistance to fracture and strength of an object.	*Structural Integrity and Foundation*	Lithuania
C9	Vizzarri (2020) considered political attributes *as government regulations and policies* which includes national laws, the urban management and landscape protection. Britannica (2023) defines regulations in government as a mechanism or rule that steers, limit or otherwise directs social behaviours	*Government regulations and policies*	Italy
C10	Ali et al. (2020) claimed that the construction sector plays a vital role in the *carbon dioxide (CO_2) emission* into the atmosphere in large number resulting to diverse issues that needs to be addressed. For	*Carbon dioxide (CO_2)*	Malaysia

	instance, management of carbon emission is one of the actions recommended by Labaran (2022) to address climate change.

Source: Adapted by author from several literature as denoted in the table.

The 10 criteria mentioned above were selected having considered their relationship with the five-sustainability attributes and the four alternatives. The maximum number of 10 for the criteria selection according to Wilson (2013) and Roy et al. (2019) instigated the selection of the criteria that are relevant to at least 3 out of the four alternatives as indicated in the Table 2.9. Moreso, some of these criteria are inter-related and the preference is to choose one in place of others. For instance, as there are no visible existing documents to ascertain the "*Building lifetime*" of the abandoned Federal Secretariat, the next step is to adopt a technology that would ascertain the "*Structural integrity and foundation*" of the same building.

In the same instance, Vizzarri (2020) extended the sustainability attributes beyond the Pavlovskis (2017) technological, environmental, and economic element to functional, physical, social, legal, and political. However, social, and political were adopted from Vizzarri (2020) due to further significant findings in literature review.

Other criteria such as investment can stand in for payback, while removal of contaminated soil and material could be considered if the eventual option is demolition.

Table 2. 9 : Evidence of model components selection

	Criteria initially identified	**Sustainability Attributes**	**Relevance to the alternative**
1	Project preparation and coordination	Technological	Refurbishment, Conversion, Demolition and Selling
2	Construction Work duration		Refurbishment, Conversion,
3	Building lifetime		Refurbishment, Conversion
4	Possibilities of building adaptation to current needs		Refurbishment, Conversion
5	Removal of contaminated soil and material		Demolition
6	Energy efficiency	Environmental	Refurbishment, Conversion, Demolition
7	Waste generation	Environmental	Refurbishment, Conversion, Demolition
8	Preservation of historical value	Environmental	Refurbishment, Conversion, Selling
9	Investments	Economic	Refurbishment, Conversion, Selling
10	Payback period		
11	Profitability	Economic	Refurbishment, Conversion, Selling
12	Structural integrity and foundation	Technology	Refurbishment, Conversion, Selling
Additional Criteria reviewed			

13	*Creation of employment*	Social	Refurbishment, Conversion, Selling
14	*Government regulations and policies*	*Political*	*Refurbishment, Conversion, Demolition and Selling*
15	*Carbon dioxide (CO_2)*	Environmental	Refurbishment, Conversion, Demolition

The following alternatives were identified within the literature for consideration in the redevelopment of abandoned infrastructure:

2.6.1.1 Refurbishment

Refurbishment and adaptation to current needs while maintaining or slightly changing the original building and its historically established purpose (Ogunnusi et al. 2023). Husin (2019) presents the definition of refurbishment as "a process of returning the building, or its systems, to their original condition, addressing the forces of physical obsolescence."

Humphrey (2023) opined that prioritizing the refurbishment of existing buildings over construction of new projects is the most effectual way for the built environment to help with the net-zero target of achievement by 2050. Croatto et al. (2017) and Balaras & Dascalaki, (2019) considered refurbishment as one of the approaches to saving money and achieving cultural preservation with long-term consequences for environmental sustainability, efficiency to cut CO_2 emissions, and limits to waste materials from demolition. Yung and Chan (2012) suggested that the adaptive reuse of abandoned structure bypasses the wasteful practice of demolition and reconstruction. Revitalisation of the immediate environment and job creation can be viewed as benefits, and income generation where appropriate can be viewed as a measure of economic success.

2.6.1.2 Conversion

Conversion of a building typically considers uses such as apartment housing, mixed development, or shopping complex and may emphasise preservation of its architectural-urban expression. With the need for major modifications of buildings, Remoy and Voordt (2014) consider conversion into housing as a way of adaptation and reuse of unoccupied office buildings. The conversion maintains a durable and beneficial application of building and location which implies less revenue disruption (than with regeneration) and can have high financial and social advantages. However, some specific elements can make conversion difficult or impossible, for instance, locational attributes such as the quality and the presence of amenities and services, the proximity to noxious and dangerous neighbouring uses, and the typical accessibility of the site especially through public transportation (Madeddu and Clifford 2022).

According to Pavlovskis et al. (2017) conversion of buildings reduces consumption of energy and the level of CO_2 emissions with an improved and lengthier life. Petković-Grozdanovića et al. (2016) argued the conversion procedure should not be restricted to the prior intent of the building. Rather, it should respect the cultural background and the historical structures in amongst which the building was created. Nevertheless, both architectural and structural criteria should be considered in evaluating the suitability of conversion processes.

2.6.1.3 Demolition

Demolition of the building and the implementation of a new development. It could also be full or partial demolition (Jostock 2020). Rathi & Khandve, (2014) defines demolition as the process of dismantling, pulling down or destroying a building after its valuable lifetime period. Su et al. (2021)

estimated levels of demolition waste and carbon emissions and discovered that the environmental advantages vary according to the types of recycled waste. Moreso, Su et al. (2021) discovered that demolition waste accounts for a large percentage of about 70% to 80% of total construction waste. Nevertheless, Jin et al. (2017) revealed that demolition waste can be considered for recycling, with the environmental, economic, and social benefits of recycling demolition waste and reducing materials production in new projects, thereby saving landfill spaces, reducing emissions, and saving energy.

For instance, Naeini et al. (2021) identify the blends of recovered plastics within construction and demolition (C&D) waste. The blends of these recovered plastics as a supplementary to C&D waste can enhance the energy absorption of the C&D aggregates. In an energy efficiency assessment study conducted by Porras-Amore et al. (2021), the findings indicate that substitution of traditional constituents with recycled constituents demonstrate economic and energy savings due to the decrease in the quantity of the raw materials used. Although construction waste stream constituent complexity is not a formal consideration within the current version of the tool at this point in the thesis.

A building can also undergo 'selective demolition" known as deconstruction or "construction in reverse." This is an order of demolition actions which permits the separation and arrangement of construction elements and important materials of the building such as bricks, metals, doors, windows, plasterboards and so on (Pantini and Rigamonti 2020). The application of BIM, especially at the demolition phase, in recovering building components and materials for recycling or reuse was also investigated by Akinade et al. (2015) who reinforced the need for planning for the end of construction from the design phase with the aid of tools such as "BIM-based Deconstructability Assessment Score (BIM-DAS)." There are diverse design guidelines that should be adhered to in terms of developing the deconstructability of structures. For instance, Akinade et al. (2015), Kanters (2018), and Obi et al. (2021) all agree that the design guidelines for deconstruction must be automated, objective, conceptualised, mathematically depicted and created into a model.

2.6.1.4 Partial or outright sale to private sector/ entities or investors

Apart from the three options, alternative mentioned in Section 2.6.1, the building can be sold partially or outrightly to entities or investors. According to Collins dictionary, "selling" means to transfer, dispose of, object or property to purchaser in exchange for other consideration or money. Nigeria can take cue from other countries that will rather sell unused property than allowed to be abandoned. For instance, UK ministers have developed plans to sell E1.5bn of government buildings (Pickard and George 2022; Markson 2022; Allegretti 2022). This is also similar case of Nigerian government (relocating the government seat from Lagos to Abuja – Table 2.3) with UK government contemplating moving more officials out of the London to encourage more remote work. This sale can also help with budget cut to make adequate use of government assets and resources.

Gilbert (2018) states that local authorities in England increased the sales of over 4000 public buildings to support their ever-increasing demand for services. Canada is another nation with government selling surplus property which are being repurposed by the buyers for low-income and senior housing (Botting 2020). Alternatively, these buildings can be sold to the private sector for market value (Entwistle 2021) The argument is for the governing administrations to ascertain a

balance between end - user affordability and the need of private and public investors to recover the cost of infrastructure investment.

2.6.2 TOPSIS and its application

Despite several publications on multi criteria decision making (MCDM), there exists a gap in the application of MCDM TOPSIS to the redevelopment of abandoned infrastructure (Ogunnusi 2023). In assessing the sustainable development of territorial units, Luczak and Just (2021) adopted the application potential of MCDM TOPSIS in which the technique for order preference by similarity to an ideal solution (TOPSIS) technique 'amends' MCDM.

TOPSIS was initially developed by Hwang and Yoon in 1981 (Rohmatulloh and Winarni 2014; Rahim et al. 2018; Balioti et al. 2018). According to Zhao et al. (2022) TOPSIS requires lesser mathematical procedures than VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) to formulate an effectual decision. Evidence from Tomic et al. (2019) suggests the application of VIKOR to rank storage options and possible leakage pathways for CO_2 through poorly plugged abandoned well, while Antucheviciene et al. (2012) utilised it for the identifying rational development trends of abandoned rural buildings. Kabir et al. (2014) also reviewed VIKOR as decision making method for infrastructure management. However, none of these publications applied VIKOR for the redevelopment of abandon public office buildings. VIKOR is also one of the MCDM Techniques as noted by Zhao et al. (2022) while asserting that TOPSIS can also be applied using many indicators. Basically, TOPSIS is used to define both the negative ideal solution (NIS) and the positive ideal solution (PIS). The optimal solution is one farthest from the NIS and closest to the PIS.

Through the NIS and PIS evaluation, TOPSIS supports decision-makers to contemplate the needs of diverse stakeholders and to choose the optimal solution. Shen et al. (2018) presented an illustrative example of NIS and PIS in a group decision environment, with each individual decision being expressed as an interval matrix employing the Euclidean distance (Chapter 3, Section 3.8.2.2 for more detail) as a measure of separation of an individual decision from the ideal solution and the comparative closeness to the ideal solution. Similarly, Krohling and Pacheco (2015) further asserts that the best alternative would be the closest to the positive-ideal solution while being farthest from the negative ideal solution.

This enables the calculation of the value of the alternatives and ranking of them in order of merit to assist the decision – makers make selections. Rohmatulloh and Winarni (2014) attested that TOPSIS is broadly used by practitioners and researchers owing to its easy, simple computation procedure, and "mathematical model".

2.6.3 Reviewing MCDM TOPSIS Models

Wang et al. (2020) define a MCDM Model as an effectual tool applied to proffer solution to multifaceted collation issues including alternatives and multiple criteria. Klumbyte et al. (2021) applied a MCDM model for sustainable decision-making adapted to public residential building facilities management. According to Erdogan et al. (2019), the MCDM model is increasingly applied to explicate sustainable construction matters such as evaluation and analysis of different descriptions involving stakeholders, a broad range of ecological administration challenges, and construction risk management studies amongst others. Table 2.10 present studies where a TOPSIS Model has been applied.

Table 2. 10 : Literature reviews of TOPSIS Model

N.	Description	Author(s)
1	A TOPSIS model for understanding the authors choice of journal selection	Durmusoglu and Durmusoglu (2021)
2	Credibilistic TOPSIS for evaluation and selection of municipal solid waste disposal methods	Roy et al. (2019)
3	Evaluation of the sustainable development of an Island "Blue Economy": A case study of Hainan, China.	Fang et al. (2021)
4	Selection of building material supplier	Chen (2020)
5	Software selection.	Hanine et al. (2016)
6	Development of Crisp and interval data.	Roszkowska (2011)
7	Evaluation of subsea energy supply systems for enhanced maintenance.	Emuchay et al. (2021)
8	Wastewater treatment plan selection	Zhou et al. (2018)
9	Using the Entropy and TOPSIS Models to evaluate sustainable development of Islands: A case in China.	Zhao et al. (2022)

Source: Adapted by author from several literature as denoted in the table.

All the models previously mentioned (Table 2.10) were not considered within this study. The reason being that they are pure mathematics models and may not be considered sufficiently user friendly for usage by abandonment scenario decision makers. Akande et al. (2021) and Umar (2019) therefore pointed that a practicable model (as a tool) that would be pitched towards restoring abandoned municipal facilities should be designed. This will lead to the development of a graphic user interface (GUI) to present TOPSIS as a tool for the decision-making process.

In this regard, with reflection on flexibility and ease of usage (as discussed in Chapter 5 Table 5.1), a TOPSIS Model is being proposed in this context. This attempt in essence underpins the sustainability assessment of the 'vacated building' as mentioned in section 2.4. and enhances the robust interconnection that links diverse sustainable components as noted by Vacchi (2021) in section 2.2.1.5. To ensure the effective assessment of this building, a sustainable framework (Figure 2.12) is relevant within this context to enable the decision makers to comprehend the imperative aspects of sustainability implementation (Goni et al. 2021).

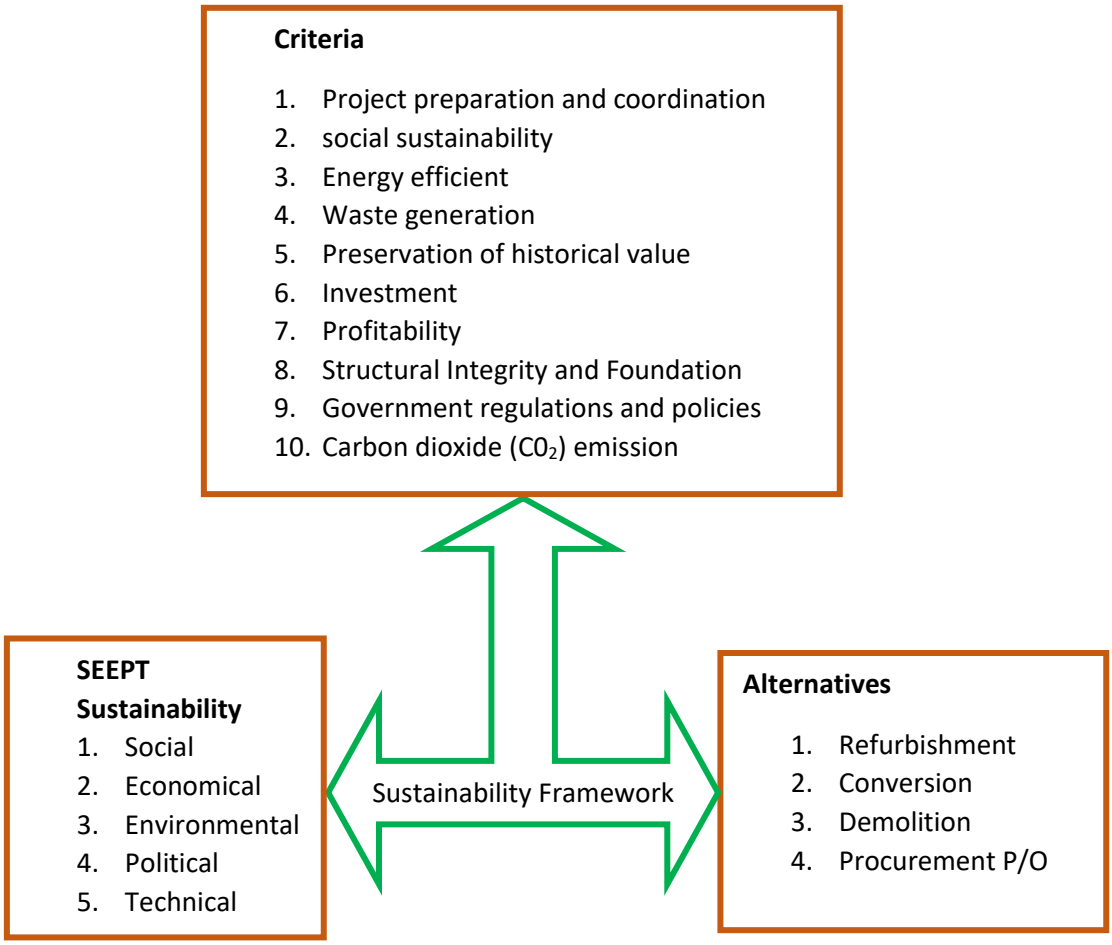


Figure 2. 12 : Sustainability Framework.

Source: Author generated

2.6.4 Criteria Weightage

In models, assigning weight to criteria is an imperative action, which is classified by Odu (2019) into three weighting methods (Table 2.11) of subject, object, and integrated weighting methods. They are further illustrated as follows:

Table 2. 11 : Criteria Weightage

	Subjective methods	Objective methods	Integrated method
1	Pairwise comparison-Analytical Hierarchy Process (AHP)	Mean Weight	Multiplication synthesis
2	Point allocation	Criteria Importance Through Inter-Criteria Correlation (CRITIC)	Optimal weighting based on relational coefficient of graduation
3	Nominal group technique	Standard deviation	Optimal weighting based on sum of the squares.
4	Ranking method.	Entropy method.	Additive synthesis

Bearing in mind the influence of the weight of criteria on the overall outcome of the decision-making procedure, it is necessary to consider the objectivity components of the weight of the criteria. For instance, the weight of the criteria in objective weighting methods are obtained from the information collected in each criterion via mathematical models void of any attention to intervention from the decision maker. The reverse is the case with the subjective weighting methods as these methods allow the integration of the expert's influence with the criteria weight. The integrated weight methods are the combination of both objective and subjective weighting methods. Zhao et al. (2022) stated that objective data help with further understanding of the differences between alternatives. To avoid bias and disregard, the objective weighting method will be adopted in the context of this study.

According to Pamucar et al. (2018), determining the weight of a criteria is one of the key challenges that occur in MCDM. There are various weighting approaches (as listed under the objective weighting methods) that have been suggested and adopted for solving diverse MCDM issues. For instance, Gao et al. (2017) adopted the CRITIC weighting method including correlation analysis to identify the national options for a sustainable nuclear system in Korea. Furthermore, Karageyik and Sahin (2017) explored the standard deviation principles in determining the optimal retention level based on different measures.

Jahan et al. (2012) and Zhao et al. (2022) calculated weightage using the entropy weight method. Chang and Cheng (2019) used the entropy weight method to "determine the relative importance of factors evaluated in the decision-making models". Ogunnusi et al. (2023) also adopted mean weight to address insufficient information with regards to criteria weight calculation. Figure 2.13 further shows the distribution of application of Mean weight, TOPSIS and Entropy weight among publications.

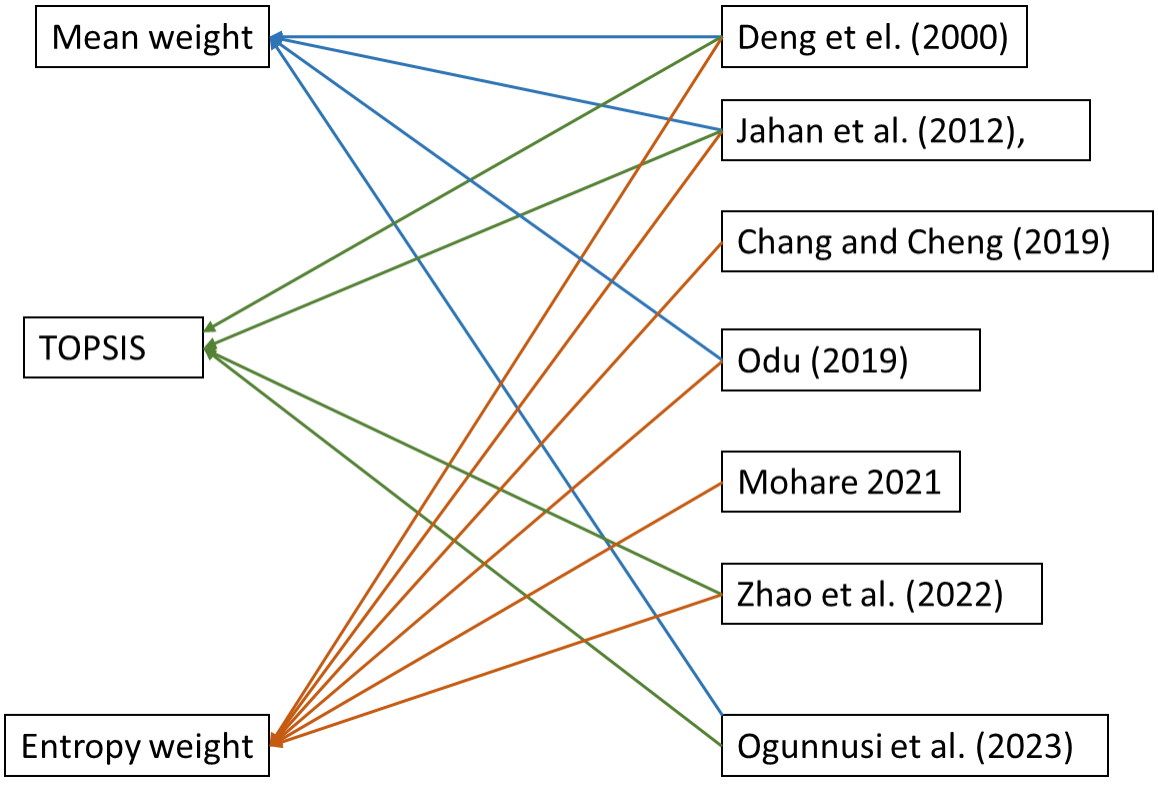


Figure 2. 13 : Criteria weightage adopted in publications.

Considering the evaluation of the objective weighting processes, the criteria weightage calculation will be further considered in methodology, analysis, and model development chapters (Chapters 3, 4 and 5) respectively. With the review of the criteria and alternatives, then it is rational to recommend that the next phase of the procedure would be to discover a means of considering all these alternatives and criteria within a singular activity or model.

2.7 Integrated of Multiple 5Rs system for abandoned infrastructure waste management.

With waste of useful resources having been mentioned severally in Section 2.3, this section focuses on how the 5Rs concepts can be adopted to resuscitate abandoned infrastructure in Nigeria while curbing the challenges faced in the Nigerian environment. These new concept attempts to promote waste management required to be done effectively.

The need arises to proffer a solution to this growing menace hindering the socio-economic atmosphere of the country. With quantitative methods, Nwanekezie & Nwanguma (2019) Ogunnusi et al.,(2021) and Ogunnusi et al., (2022) studied the causes of uncompleted and abandoned building projects; Doraisamy et al., (2015) reviewed the effects of abandoned construction projects and Alao et al., (2019) assessed resuscitation strategies for abandoned projects. However, none evaluated the research qualitatively, focusing on the 5Rs concept (through qualitative content analysis) of a rethink, reduce, reuse, refurbish, regulation to address the waste management approach.

The traditional concept of the R system, which progressively gained attention in the US and Europe in the 1970s, comprises only the three Rs" of reduce, reuse and recycle (Reike et al., 2018; Abdul-Rahman, 2014; Goyal et al. 2018). Nevertheless, there is a new concept that encompasses multiple R systems that include rethinking, reducing, reusing, refurbishing, and regulation (Figure 1) as part of the study conducted by Govani et al. (2021); Kirchherr et al. (2017). Waste management are being viewed more from product waste more than building waste. Authors such as David et al. (2019) listed waste production from glasses, electronics, papers, foods, and plastic manufacturing, excluding buildings, while Lei et al. (2020) considered waste generated from wood, concrete, and asphalt shingles, steels and bricks. Quite a few scholars, such as Boo & Kwon (2018); Cascone & Sciuto (2018), related the concept of "Reuse" to existing abandoned buildings, hence the preference for linking the 5Rs concepts to abandoned infrastructure redevelopment in Nigeria.

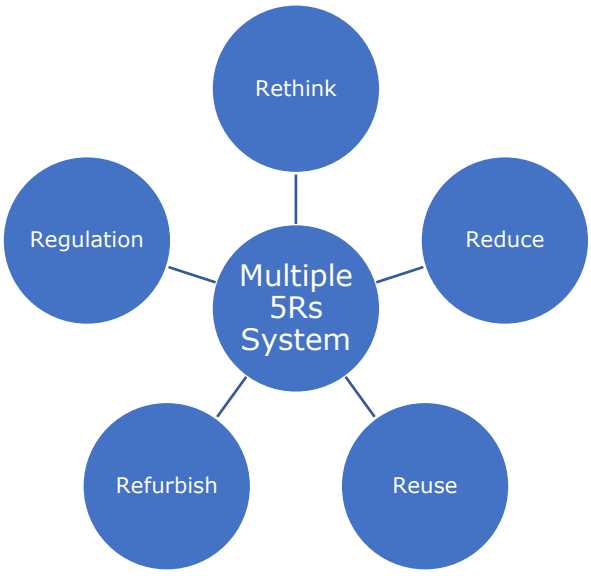


Figure 2.14 Multiple 5Rs Systems

2.7.1 Rethink

Rethink is the first on the multiple R systems identified by Govani et al. (2021). Rethink is the initial process required before using products that will be a waste once used. Rethinking is to prevent procuring needless materials for decorative or luxury purposes. To rethink is to select a wiser option for a sustainable product as a substitute for one-time use and subsequent abandonment. For instance, in regenerating lively spaces out of abandoned industrial wastelands, Arup (2014) emphasised the need for drastic rethinking of solutions to be implemented in the project. Rethinking is a huge responsibility for leaders, as Dinika (2022) concluded.

2.7.2 Reduce

To reduce is to lessen product consumption however and wherever possible. Not promoting or procuring single-use products and needless products can reduce the amount of waste generated. Maintaining things, using and handling them can enhance waste reduction (Govani et al. 2021).
Francis, cited by Reike et al. (2018), described "reduce" generically as it is all about eliminating the production of waste rather than the disposal of waste itself after it has been created. David et al. (2019) further supported reducing raw material consumption for new products. In other words, the most effective approach to reduce negativity from the environment is to enhance the design of products for waste prevention.

2.7.3 Reuse / Resell

One of the essential strategies of the multiple R system is reuse. Reusing helps to make absolute use of produced materials while preventing waste generation. For instance, used tyres could be used as an alternative fuel in some industries and recreational purposes. The material can be reused until it exhausts its potential to be used in the same shape (Govani et al. 2021). With the end-stage of every product, some parts can be improved for reuse purposes (David et al 2019). Reike et al. (2018) claimed that the concept of 'reuse' or 'resell' are closely linked, expressing the double side of the market transaction required to bring back the product into the economy after previous use. Reuse practices should not be limited to some rural environments, as noted by Mihai et al. (2022).

2.7.4 Refurbish

In addition to discussion in section 2.6.1.1, damaged and old materials are not always useless or turn to waste. Rather, they can be refurbished innovatively. Refurbishment can enhance waste reduction by adding used and old stuff value. For instance, ancient structures are refurbished into buildings with a modern touch (Govani *et al.* 2021).
Reike et al. (2018) state that refurbishment seems to be most suitable in situations where the entire structure of a "large multi-component product" remains complete while several components are repaired or replaced, leading to a total upgrade of the product. The concept of refurbishment is also recognised from shared language within an overhaul.

2.7.5 Regulation

Govani et al. (2021) state that robust implementation of regulations by the government of any country impacts processing and minimising waste. Reike et al. (2018) also pointed out that developing

countries with weak regulations encounter illicit and illegal importation of waste from Europe. Complexities and variations in regulations highlighted by Goyal et al. (2016) can increase the gap between limited resources and increasing demand. In other words, the psychological behaviour, and challenges to change from a "*use and throw mindset*" can be regulated.

The benefit of applying the new 5Rs concept is not only to enhance the waste management of abandoned infrastructure but also to encourage the practice and application of other waste management strategies such as the circular economy.

2.8 Chapter Summary

This chapter determined the segments of infrastructure in the context of development and sustainability in developing countries. The value of infrastructure development and sustainability in Nigeria was discussed and compared with other countries.

The causes and the impact of the abandonment infrastructure as obtained from relevant literature were also discussed, through comparison to other countries and in the Nigerian context.

Infrastructure sustainability and the sustainability model with the five sustainability attributes which include social, economic, environmental, political, technological were reviewed.

The redevelopment strategies adopted by different authors, in different countries were also highlighted. The argument from this point is that solutions previously provided in the literature requires the sustainability and decision-making standpoint of view. Moreso, findings from literature presented problems and solutions in segments. Hence, a holistic approach will be beneficial at this point to enhance a comprehensive approach. Therefore, this study proposes the adoption of a decision-making approach when confronted with multiple solutions.

The chapter also examined the concept of MCDM TOPSIS Model as an underpinning concept with a comprehensive method from the point of identifying possible alternatives and criteria for addressing the redevelopment of abandoned infrastructure.

The 5Rs concepts, which include rethinking, reducing, reuse, refurbishing and regulation as an alternative for waste management were adopted to resuscitate the challenges encountered in Nigeria due to this menace.

The succeeding chapter will discuss the methodology adopted within this research to connect the theories within this chapter resulting to data collection and analysis.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 INTRODUCTION

This chapter outlines the methodological framework, method of data collection and approach to data analysis. The research philosophy, the research strategies and the methodical approaches applied within the three studies to deliver the aim of this research was also presented. This creates the research environment within which evaluation can occur and provides justification for the selected methodologies.

3.1 Research Methodology

Zukauskas et al. (2018) defined methodology as a set of rules, values, principles, theories, and methods on which the study is implemented. Likewise, McGregor (2019) described methodology as a field of philosophy that examines the procedures and principles of investigation in disciplinary research.

Fundamentally, Creswell and Creswell (2017) and Leavy (2017), stated that the research methodology of a study encompasses techniques and procedure applied by the researcher to recognise, choose, and evaluate the research data to accomplish the aims and the objectives of the study. Goundar (2012) defined methods as a process for conducting research into a topic or subject comprising the conduct of tests, experiments, surveys etc. The knowledge obtained from research methods promotes the advancement of an intellectual discipline (Daniel 2018).

For ensuring appropriate structure within this chapter, some of the steps highlighted in Saunder et al. (2019) suggestions of a research 'onion' in Figure 3.1 are adopted.

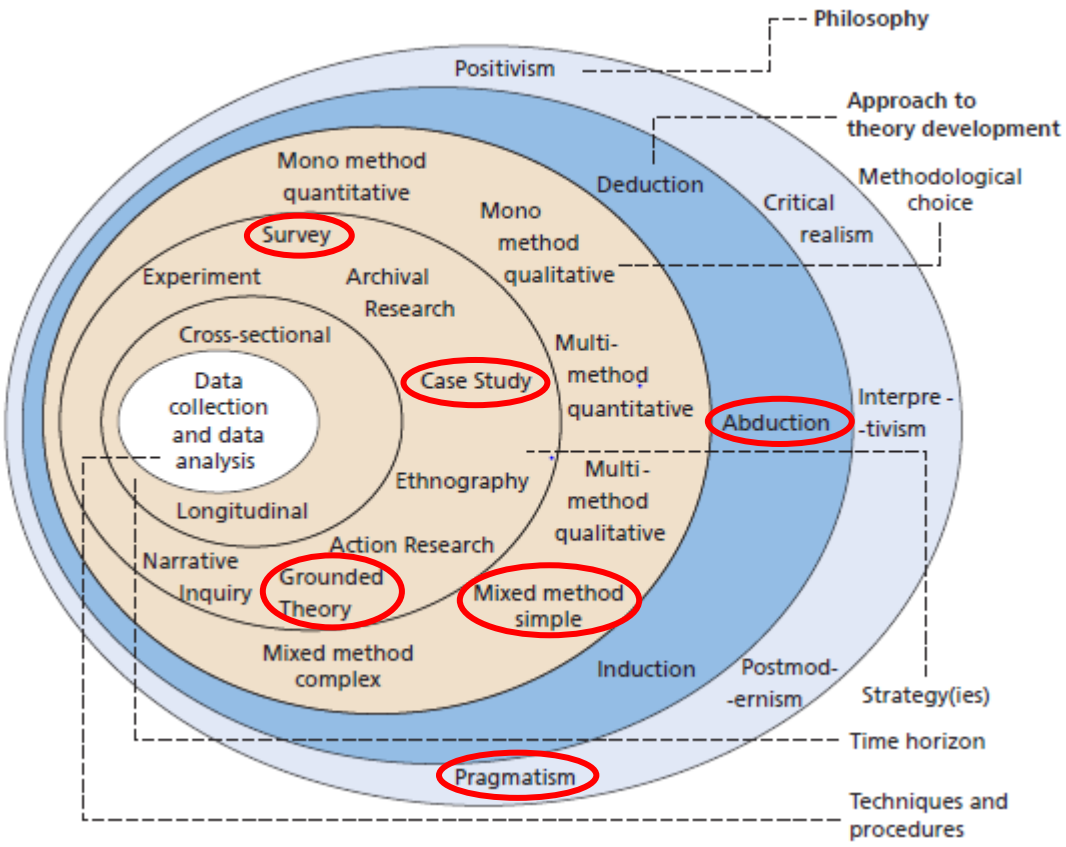


Figure 3. 1 : Research Onion

Source: Saunders et al. 2019

3.2 Research Philosophy

Philosophy consideration is in the outer layer in the research onion as identified in Figure 3.1. According to Zukauskas et al. (2018) and Saunders et al. (2016), philosophy is considered as a system of researcher's cogitation and beliefs wherein innovative, dependable learning, and assumptions about the research aim is attained. This reinforces the researcher's methodological selection, research approaches, data compilation procedures and analysis processes. A researcher's view of what comprises knowledge and truth guides and reflects their belief, thinking and assumptions about their society and global view which is also referred to as a paradigm (Kivunja and Kuyini 2017). Khatri (2020) also supported the argument, referring to a research paradigm as simply the philosophical or theoretical premise for the research work. The five paradigms of philosophy based on Saunders et al. (2019) listed in Figure 3.1 are positivism, critical realism, interpretivism, post-modernism and pragmatism. The five paradigms are further evaluated in the context of this study in sections 3.2.1.1 – 5 and Table 3.1.

3.2.1.1 Positivism

Positivism was inspired by philosophers Descartes and Locke in the Enlightenment period of the 17th and 18th centuries. According to Park et al. (2020), positivism depends on the hypothetico-deductive method to validate a priori-hypotheses that are frequently identified quantitatively. In this regards, functional relationships are obtained between explanatory and causal factors (independent variables) and the outcomes (dependent variables).

Zukauskas et al. (2018) stated that the concept of positivism is precisely related to the notion of objectivism. Applying this philosophical method, the researcher communicates their views in order to evaluate the social world and refer to objectivity rather than subjectivity. Positivism correlates with the philosophical viewpoints of the biological sciences and involves working with an evident social experience to generate principled generalization (Saunders et al. 2019).

3.2.1.2 Critical realism

Sturgiss and Clark (2019) define critical realism as a set of philosophical principles that can advise a broad variety of qualitative, quantitative, and mixed-method outlines, and which tries to comprehend diverse phenomena. It is useful for comprehending why and how things occur, as well as unfolding the impact of context on a program outcome. Critical realism is another philosophical stance that asserts to proffer an account of class of scientific procedure (Bryman 2012). Saunders et al. (2019) advised not to confuse the critical realism philosophy with the more excessive type of realism underlying the positivist philosophy. Critical realism is a relayed experience of what is seen, felt, or heard etc. in a specific situation, presenting a justification for beliefs and values (Zukauskas et al. 2018).

3.2.1.3 Interpretivism

McBride et al. (2021) identified interpretivism as one of the fundamental philosophical positions in the social sciences which proffers a robust support for clarifying and generating knowledge about convoluted social experiences. In Zukauskas et al. (2018) study, interpretivism can still be referred to as “social constructionism” in the domain of management, and the philosophy cannot be stringently severed from social sciences but must be blended or incorporated into them. Based on this philosophy, a researcher concentrates on the figures and facts equivalent to the research issues. Applying this philosophy enables researchers to make use of sample data samples and evaluate them cautiously so as to perceive the mindsets of the bigger population segments.

According to Saunders et al. (2019), interpretivism asserts that human beings and the social realm cannot be examined in the same manner as physical experiences, and that hence, natural sciences studies need to be distinct from social sciences studies rather than trying to emulate the former.

3.2.1.4 post-modernism

Post – modern is a theory that comprises a broad range of practices and ideals and is not a philosophical movement as noted by Rajshree (2012). It somewhat encompasses a number of viewpoints that can be deemed ‘post-modern’ with the most typical involving post-structuralism and feminism. In addition to this, Elaati (2016) also considers post modernism as literary, intellectual, technical, and monetary schools that have emerged after postmodern school of linguistics, semiotics, and structuralism. However, Raj (2016) argued that post-modernism eludes definition owing to its

extensive and differing nature as it is interconnected with attitude, life, and culture, thereby making it a challenged classification.

Table 3. 1 : Further description of paradigms

Philosophies	Further description of the Paradigms
Positivism	Positivism refers to imperativeness of what is 'posited', that is, 'given' laying emphasis on the positivist concentration on precisely scientific realist empiricist approach aimed to generate pure facts and data that are not influenced by human bias or interpretation (Saunders et al. 2019). The empiricism of a positivist approaches sought objectivity in a manner that failed to comprehend social phenomena (Ryan 2018).
Critical realism	Critical realism originated in the late twentieth century in the Roy Bhaskar study (Robert 2014; Saunders et al. 2019; Sage 2012). It is a definite type of realism whose philosophy is to identify the actuality of the natural mandate, the occurrence, and the discussions of the social realm. The criticality of the realism in this context is based on the premise that the recognition of the generative system proffers the potential of initiating reformations that can modify the status quo (Bryman 2012; Stutchbury 2022).
Interpretivism	In comparison to critical realism, Saunders et al., (2019) also asserts that interpretivism resulted as a critique of positivism, however, from a subjectivist viewpoint. Still on positivism criticism, McBride et al. (2021) argues that interpretivism lean towards inductive research rather than deductive, consider reality as somewhat socially fabricated, and is concentrated less on attempting to recognize an unbiased reality, but to a greater extent on comprehending and reenacting how the themes of the research have appeared to form a decision attained.
Post-modernism	Rajshree (2012) and Sheeba (2017) argued that postmodernism is commonly acknowledged as having been envisioned in art about the end of the nineteenth century as a counter response to the boring legacy contemporary art and proceed to develop into other fields during the early twentieth century as a counter response against modernism generally.
Pragmatism	**Pragmatism** Alghamdi et al. (2013) states that pragmatism does not have its place in any philosophical reality and system. Researchers with freedom of choice are unrestricted to select the methods, procedure and techniques that exceptionally meet their scientific research aim and their requirements. Kelly and Cordeiro (2020) states that with epistemological consideration, pragmatism is initiated on the impression that research study can concentrate on "practical understanding" of solid real-world issues and steer clear of philosophical debates about the nature of reality and nature.

3.2.1.5 Pragmatism

Pragmatism considers rational thinking and actions as the key, and the principle of truth is measured for its rational application (Zukauskas et al. 2018). Kelly and Cordeiro (2020) also clarifies that pragmatism maintains the meaning and the value of facts and opinions as encapsulated in research data and evaluated across the investigation of their realistic consequences.

Kaushik and Walsh (2019) concluded that pragmatism is a paradigm that asserts to connect the gap between scientific approaches and structuralist positioning of older methods and the naturalistic approaches, and freewheeling positioning of newer processes. McBride et al. (2021) argued that pragmatism is somewhat more distinct than other philosophies in that action must precede concept, learning and comprehension as the possibility of attaining these is through action. Hence, pragmatism exists somewhere in the middle of the ontological extremes of interpretivism and positivism. Subsequently, in terms of methodology, pragmatics habitually emerge in the application of mixed methods (Regnault et al. 2018) study as shown in Table 3.2.

With the measurement ability of positivism, it could be considered enough to identify the causes of abandoned infrastructure through a positivism philosophical paradigm (objective - questionnaires) as adopted by Olalusi and Otunola (2012); Amade et al. (2015); Ogunnusi et al. (2021). Alternatively, obtaining possible solutions to abandonment through an interpretivism philosophical paradigm (subjective – interview) as adopted by Ogunnusi et al. (2022) could be implemented. However, robust study including validation in this research context is necessary. This requires the combination of both the objective and subjective ontological stances. The validation activity involves the demonstration and testing of the TOPSIS Model (TOPMod) that requires a mixed method approach of quantitative and qualitative study.

Nowell (2015) argued that the existence of pragmatism is not an antecedent phenomenon, but on consequent phenomenon and potentialities of action. In essence, the argument is that general ideas should be the foundation for establishing future experiences and observation, instead of reporting past experiences. The adoption of pragmatism in this research (based on its focus on real knowledge) will underpin the identification of the consequential relevance of TOPMod during the validation process. In this view, the pragmatist philosophical paradigm was regarded as the most appropriate for this research. This is because it would create a platform for the researcher to explore more than one research method, to unfold as many features as possible, and possible solutions for the redevelopment of abandoned infrastructure.

Table 3. 2 : Comparison of Positivism, Interpretivism and Pragmatism

	Ontology	Epistemology	Methodology
Positivism	Objective reality	Knowledge is real and objective, obtainable via measurement and statistics (reductionism)	Surveys, experiments, statistical analysis
Interpretivism	Subjective reality	Knowledge is dependent on beliefs, values, and lived experience (constructivism)	Field studies, case studies, hermeneutics, phenomenology
Pragmatism	Objective/subjective	Knowledge is obtained by doing and acting	Mixed-methods research, action research, design science

Source: McBride et al. (2021)

3.2.2. Philosophical Assumptions

Creswell (2013) affirms that researchers sometimes (obliviously or intentionally) infuse specific philosophical assumptions and beliefs in their research work. Creswell and Poth (2018); Saunders et al. (2019) further expressed that there are three main kinds of intentional or obvious assumptions concerning realities:

1. epistemological assumptions (*What constitute appropriate knowledge with justification*),
2. ontological assumptions (*What is the nature of being or reality)*, and
3. axiological assumptions (*The role of values).*

The assumptions in Table 3.2 basically influence a researcher's appreciation of their study questions, selection of approaches, and analysis of outcomes. Ontology, epistemology, methodology and methods articulate all research paradigms (Zukauskas et al. 2018).

3.2.2.1 Ontology

Ontology is an area of philosophy which is involved with the nature of being and with what exists – 'What is there'? (Scales 2013; Al-Saadi 2014; Saunders et al. 2016). To support this, Creswell (2013) also agreed that ontological assumptions in social science are associated characteristics and the nature of realities. Ormston et al. (2014) claimed that ontology involves inquiry about whether or not social reality exists separately from human interpretations or conceptions, and directly associated with this, either there is a common societal reality or only context-specific, multiple ones.

Ontology is considered as comprising the wide-range assumptions established to observe the real-world societal nature to aid the understanding of the real nature of-society (Zukauskas et al. 2018). Relaying the relationship and the strong connection for methodological sequence consideration, Aldawod and Day (2017) argued that ontology precedes epistemology, which is in turn followed by research methodology.

3.2.2.2 Epistemology

Scales (2013); Osobajo (2017); IEP (2021) claimed that epistemology is about assumptions of learning and how 'propositional' knowledge of things is attained and communicated. It is basically about 'how do you know'? A major question in a study is the limit to which reliable and secure knowledge of something, or anything, can be obtained. Moon et al. (2021) further acknowledged the importance of epistemology in creating solutions to modern challenges confronting convoluted socio-ecological composition, where a range of practices and disciplines converge with their own assumptions and processes regarding the legitimacy and adequacy of knowledge. In addition to these, epistemology then correlates to the type of knowledge that people or a group of people discover or create (Moon et al. 2021). Zukauskas et al. (2018) described epistemology as the wide-range assumptions and parameters related with an exceptional means to delve into the real-world nature.

Godwin et al. (2021) believed that epistemology is one part of the philosophical assumptions that impacts on which methodologies and methods can be considered appropriate by the researcher. All features of the study methods are apprised by the researcher epistemology, from rooted assumptions about what is understood to the formation of theories, research problem statement and the research design. Epistemologies also impact how the study is interpreted and fathomed within a research society after the dissemination of the results.

3.2.2.3 Axiological

Saunders et al. (2016) defined axiology as an area of philosophy that is concerned with the roles of ethics and values within the research procedure. These values are imperative as they possess a significant impact for many features of the research procedure, which include framing the research questions, selecting the research assumptions, developing the conceptual framework, determining the key process of data gathering and data examination, selecting the research context, and identifying the avenue to present the result. With this, Aldawod and Day (2017) further observed that values pervade every aspect of the study process, hence, concluding that, with the robust link between the other three philosophical assumptions and axiological assumptions, e.g ontology can be further presented claiming that the relationship is accomplished only when the axiological concerns are considered as shown in Table 3.3.

Table 3. 3 : Evaluation of the five key philosophies

Assumptions	**Ontology** *(What is the nature of being or reality)*	**Epistemology** *(What constitute appropriate knowledge with justification)*	**Axiology** *(The role of values)*	**Research Methods**
Positivism	The reality is perceived and objective. "Real, external, independent", Single true reality (universalism) "Granular(things) ordered."	Knowledge acquisition is not associated to moral and value content. Evidence of objective and real knowledge obtainable through statistics and measurement. (reductionism)	Object stance is maintained within the research. Value-free study. Researcher is detached, independent and neutral of what is researched	Experiment and surveys, statistical analysis. Usually deductive, extremely structured substantial samples, measurement, usually quantitative approach of analysis, but a selection of data can be evaluated
Interpretivism	Reality and the researcher are inseparable. The reality is subjective.	Knowledge is created of human experience, values, beliefs and centered on the theoretical description of meaning. (Constructionism)	Contextual, value laden. Researcher understanding is crucial to the contribution. Researchers are part of what is being studied, subjective.	Ethnography, Interviews, case studies, field research, phenomenology. Usually, inductive. Little samples, exhaustive investigation, qualitative approach of evaluation, but a selection of data can be interpreted.
Critical realism	Objective configuration. External, impartial. Intransient. Casual systems. Layered/ stratified (the empirical, the real and the actual.	Realities are social constructions. Epistemological belief. Historical informal explanation as input. Knowledge traditionally located and transient.	Researcher recognises bias by cultural experiences, world views and upbringing. Value-laden study. Researcher is as objective as probable.	Range of approaches and data forms to suit topic concerns. In-depth, retroductive historically located evaluation of pre-existing forms and emerging agency

Postmodernism	Nominal, Convoluted, rich, socially formed through power interactions. Some interpretations, meanings, realities are silenced and dominated by others. Flux of experiences, processes, and practices.	Dominant ideologies decide what counts as 'truth' and 'knowledge'. Exposure of challenge of prevailing views and power relations as contribution. Concentration on silences, absences and repressed/ oppressed meanings, clarification, and voices.	Some study narratives silenced and repressed at the expense of others. Value-constituted research. The researcher is radically instinctive. Researcher and the study entrenched in power.	Selection of data forms, usually qualitative approach of analysis. Usually deconstructive - studying texts and realism against themselves. Comprehensive examinations of silences, irregularities, and absences.
Pragmatism	The ontology is based on history, language, and culture respect, although the reality is ambiguous. It has combination of objective and subjective reality.	The researcher restores objective and the subjective assigned meaning of other actions.	Practical and value laden	With the research problem and question, selection of approaches such as multiple, mixed, quantitative, qualitative, action research, case study, interview, surveys Mixed-methods research, design science. "Emphasis on practical solutions and outcomes".

Source: Adapted from Zukauskas et al. (2018), Creswell (2013) p. 21**,** and Saunders et al. (2019), Allemang et al. (2021), Mcbride et al. (2021), Alan Bryman (2012)

Having critically reviewed philosophical paradigms (Table 3.3), pragmatism, as earlier stated in section 3.2.1.5, is the most appropriate paradigm for this research. This decision was made because pragmatism enables the researcher to adopt a variety of interrogation techniques that are necessary to address the research's main aim (Dawadi 2021).

3.3 Approach to theory development

Dudovskiy (2016); Mitchell (2018); Saunders et al. (2019) and Douven (2021) identified three key methods to theory development; induction, deduction, and abduction. Bryman (2012) pointed out that the inductive strategy of connecting theory and data is related to qualitative data.

An inductive approach to theory development entails a researcher beginning with the data collection designed to investigate a phenomenon to build or generate a theory. This typically, is in the manner of a conceptual framework. In contrast, a deductive approach commences with the theory evolving from a literature search and advancing to the study design to examine the validity of such theories (Saunders et al. 2019). An abductive approach includes a data collection by the researcher to examine a phenomenon, recognise themes and elucidate patterns, such that a new concept can be articulated, or an existing concept can be improved, which will then be tested further and validated through supplementary collection of data (Mitchell 2018; Saunders et al. 2019; Behfar and Okhuysen 2023).

Pierce developed abduction in 1960 - 1979 as a third mode of inference or reasoning with the application of different terminologies such as presumption, retroduction and hypothesis (Kennedy 2018). Abduction endeavours to re-contextualise and interpret specific phenomena within an appropriate framework or a collection of ideas in a manner that endeavours to explicate underlying mechanisms and causal structures (Tikly 2015). Asvoll (2014) and Stutchbury (2022) also related the imperativeness of abduction to exploring possible explanatory designs within the occurrences of a phenomenon.

The empirical study conducted by Costa et al. (2017); Kistruck and Shantz (2022) considered the abductive approach as a combination of inductive research and deductive research. Conaty (2021) argued that abduction commences from the empirical findings and not from theory, northwithstanding, prior theoretical knowledge could also underpin in providing background to the search for the most possible clarification for empirical observation. In other words, Kelle (2014) asserted that abduction demands an iterative relationship between theory and data, and data collection and analysis. In theory and data, the researcher would have to draw explicitly and implicitly on previous conceptual knowledge, while in data collection and analysis, the ongoing analysis of data implies possible hypotheses to investigate further.

Different studies such as Williams and Shepherd (2017); Marin – Gonzalez et al. (2021) and Cariani (2022) adopted the abductive method when developing new assumptions to elucidate the behavioural patterns of real phenomena. To complement the pragmatism paradigm (through supplementary data collection) as identified in Table 3.3, and to achieve this research's objectives as earlier stated (Chapter One, Section 1.3), an abductive method is the most appropriate method to the development of the theory required within the research. Abductive method will help to identify the causes and the impact of abandoned infrastructure in Nigeria leading to the development of a theoretical framework based on the Multi Criteria Decision Making (MCDM TOPSIS) technique. Moreso, the study is designed to validate its findings through supplementary data collection via interviews from academia and appropriate experts within the industry. In this sense, abduction will be applied to validate the concept that a MCDM TOPSIS Model can be utilised to address abandonment in Nigeria.

3.4 Methodological Choice

Schoonenboom and Johnson (2017); Walker and Baxter (2019); O'Reilly et al. (2021) and Riffel (2020) identified three approaches to research methodology; qualitative methods, quantitative methods, and mixed methods (Figure 3.2).

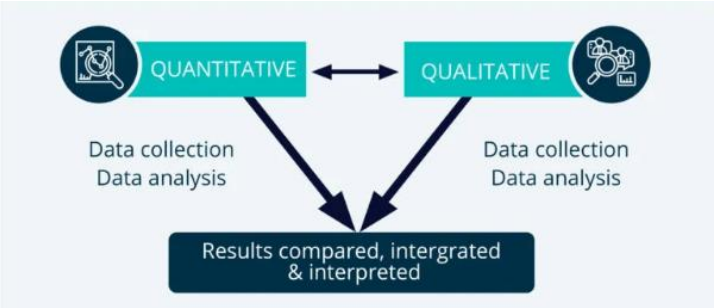


Figure 3. 2: Mixed Method Strategy

Source: Atif (2013)

Bryman (2012) clarified that qualitative research can be interpreted as a research approach that typically lays emphasis on words rather than quantification in the collation and analysis of data. Bryman further stated that research is concerned with generation of theories rather than their testing. These techniques include interviews and focus groups. Osobajo (2017) adopted the qualitative method (Figure 3.3) as the appropriate method for study to adequately investigate and achieve the knowledge of the fundamental motivations and reasons for a community's attitude and behaviour.

In contrast, Saraswati et al. (2021) presented a hypothesis that the quantitative method of data collection can generate breadth to the research by reinforcing the researcher through amassing of information about diverse features of a phenomenon from diverse participants. Daniel (2016) recognised the first advantage of a quantitative research method as being the use of statistical data as a tool for saving resources and time. It places emphasis on figures and numbers in the collation and analysis of data. This method is characterized as being constituted with predetermined hypotheses, variables, and designs.

A quantitative research methodology is a "number based research discipline" that statistically measures performance and attitudes and delivers results or data that are easier to interpret in percentages (Gounder 2012). While the process is similar to the qualitative method, Creswell and Creswell (2018) (Figure 3.3) stated that the quantitative method exhibits a more diverse approach to scholarly inquest than the qualitative method's relying on image data and text, with a distinctive step in drawing on diverse designs and data analysis. According to Busetto et al. (2020) qualitative research is characterised by responsivity, openness, and flexibility to context; the steps of data collation and analysis are not as linear and separate as they incline to be in quantitative research.

Kivunja and Kuyini (2017) and Riffel (2020) made evident that a research question and the research paradigm should ascertain which data collation and analysis methods (quantitative, qualitative, or mixed) would be most suitable for precise research. The use of various approaches may be probable to modify to any of the paradigm or all of them instead of having a single method that could hypothetically reduce and unreasonably limit the richness and depth of the study or research project.

The need for a robust and in-depth study identifies the mixed method as the most applicable method for this study, with the adoption of interviews and questionnaire deployed as seen in Table 3.3. Although a mixed method could be demanding regarding a methodological skillset, the ability to allow the research questions to be viewed from diverse perspectives makes it considered more suitable (Regnault et al. 2018) (See Section 3.7).

Dawadi et al. (2021) positioned the mixed method of research as an ethical and corresponding research method to the traditional qualitative and quantitative methods. Dawadi et al. further stated that the mixed method integrates multiple methods to tackle research questions in a principled and appropriate manner.

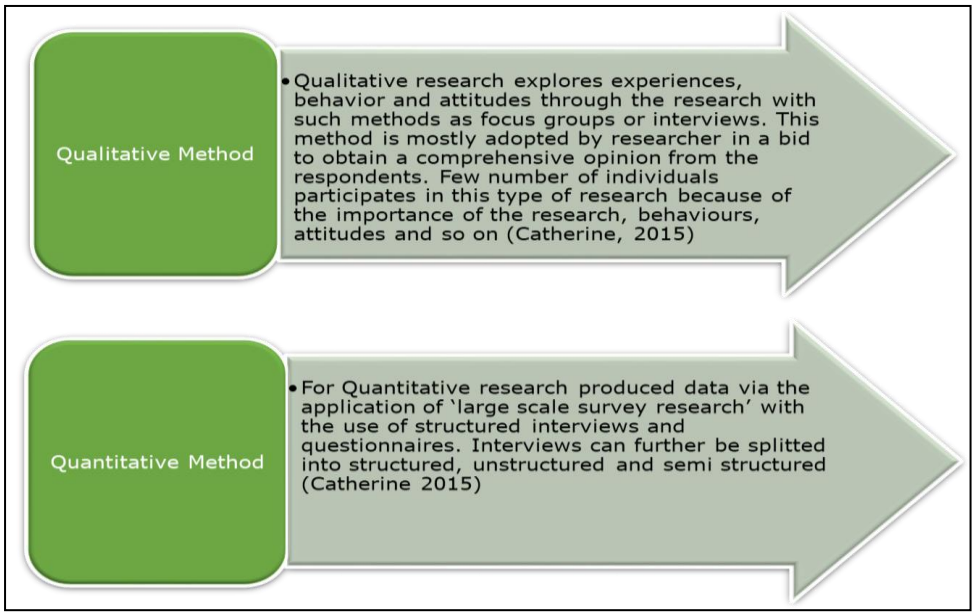


Figure 3. 3 : Qualitative and Quantitative method

Source: Catherine 2015.

3.4.1 Sequential mixed methods

The three most common types of mixed method designs identified by Schoonenboom and Johnson (2017) and Busetto et al. (2020) are the explanatory sequential design, exploratory sequential design, and convergent parallel design (Figure 3.4). Discussion of benefits and drawbacks of mixed methods is further presented in Table 3.4.

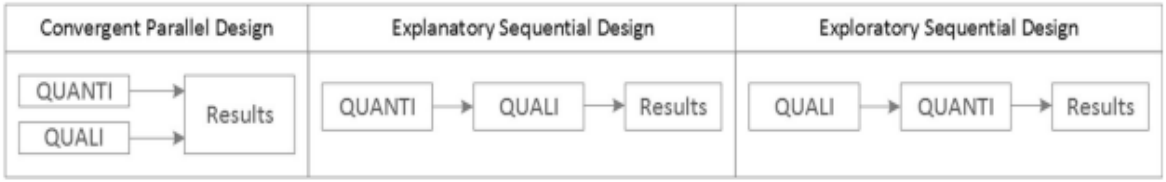


Figure 3. 4 : Three common mixed method designs.

Source: (Busetto et al. 2020)

Table 3.4 presents the different sequential approaches to implementing a mixed method. Quantitative research is conducted in parallel to, and independent of, qualitative research, and the results of both are evaluated and merged at the point of interpretation of results (Busetto et al. 2020). Dawadi et al., (2021) asserted that the explanatory sequential strategy commences with the collation and analysis of quantitative data to develop the first quantitative results leading to the development of the second qualitative stage. Gounder (2012) believed that the explanatory sequential method focuses on how and why there is a connection between two or more aspects of a phenomenon or a situation, while the exploratory method is considered as an attempt in examining the probabilities of undertaking a particular research investigation.

In identifying the level of awareness and adoption of BIM in the Nigerian construction industry, Hamma- Adama (2020) adopted an exploratory sequential mixed method (Figure 3.4). The exploratory sequential approach (qualitative to quantitative) will be considered at the initial stage of this research to understand the level of abandonment in Nigeria and to obtain reflective and grounded views from the participants (Creswell and Creswell 2018).

Table 3. 4 : Advantages and disadvantages of mixed method

Approach	Advantages	Limitations
Sequential explanatory design	- Suitable when data sets of the population behavior is available - Guided by a theoretical perspective - Easy to implement	- Time and resources needed for separate data collection phases - Difficult to explore new sources of knowledge
Sequential exploratory design	- Suitable to explore a phenomenon and identify themes - Relevant variables are identified after the qualitative study	- Time and resources needed for separate data collection phases - Identified variables can be not relevant if the group is very small
Sequential transformative design	- Ensures that the views and perspectives or a diverse range of participants are represented - Deeper understanding of a process	- Time consuming, typically higher than sequential explanatory/exploratory approaches - Resources needed are typically higher
Sequential complementary design	- Address complementary questions that was not possible to investigate using the main methodology - Combines the strengths of QUAN and QUAL data	- Can be hard to connect the two findings - The secondary study could influence the first study
Concurrent triangulation design	- QUAN and QUAL data are analyzed separately - Suitable for cross-validating and confirming findings from a single study	- Discrepancies between the quantitative and qualitative findings may be difficult to reconcile
Concurrent embedded design	- Suitable when there is predominance of a data type - There are several strategies to mix QUAN and QUAL data - Shorter data collection period	- Mixing both data can be a hard challenge - Difficulties in reconciling conflicting and antagonistic results
Concurrent transformative design	- Ensures that the views and perspectives or a diverse range of participants are represented - Deeper understanding of a process - Both qualitative and quantitative studies can be executed concurrently	- Difficulties to mix both data - Difficulties in reconciling conflicting and antagonistic results

Sources: Almeida (2018)

3.5 Research Strategy

Johannesson and Perjons (2014) define research strategy as a total scheme for performing research. This strategy directs a researcher in the development, implementing and monitoring of the research. Some of the empirical strategies identified by Saunders et al. (2019); Johannesson and Perjons (2014) include narrative enquiry, grounded theory, action research, ethnography, case study, archival research, survey and experiment, phenomenology, and simulation.

3.5.1 Archival research

Das et al. (2016) considered archival research as being a much under-utilised and underrated approach of studies in management studies. To support the historical perspective, Tennett et al. (2020) discussed how archives can be applied to encourage the procedure of historical consciousness in management learners. In essence, this research is applicable to an historical study or collation of data such as court proceedings, credit histories, census data, patent office records, and educational records as listed by Das et al. (2016).

Despite the scarcity of the literature for this method, Das et al. (2016) argued that this method is a sophisticated and viable tool for researchers to utilise efficiently in a single or mixed method programme of research. Scholars have managed to enhance their research with archival research, indicating that archival research has been used by researchers in combination with other methods. Although the complexity of accessibility of archives exists as pointed by Decker (2013), nevertheless, the historical knowledge on infrastructure and TOPSIS sections 2.1 and 2.6.2 respectively were obtained from journal publications.

3.5.2 Grounded theory

DePoy and Gitlin (2016); and Noble and Mitchell (2016) agreed that Grounded Theory (GT) is a research approach involved with the creation of theory. GT is not a linear method, but a structured and flexible methodology that is appropriate when little is known about a phenomenon, with the intention of constructing or producing an explanatory theory that reveals a procedure essential to the applicable area of inquiry (Tie et al. 2019). Among the characteristics of this methodology is the intention to produce theory grounded in data. GT proffers a viewpoint that queries the perception that quantitative methodology is the only unbiased and valid means to ascertain truth about the world.

This theory represents both an approach of enquiry and a consequent product of that enquiry. GT can also be applied to modify existing theory or to develop on, or unfold variations from, what is already known (DePoy and Gitlin 2016). Altun (2019) asserts that GT illuminates an individual's comprehensions and experiences associated with a phenomenon and produces general explanations from the data. This strategy will be applied in this research to analyse the interviews.

3.5.3 Surveys

A definition of the survey method by Torchiano et al. (2017) is – "*a systematic observational method to gather qualitative and /or quantitative data from (a sample of) entities to characterise information, attitudes and / or behaviours from different groups of subjects regarding an object of stud*y." Ponto (2015) also defined survey as the compilation of data from a sample of participants/respondents through their responses to questions.

Sreejesh et al. (2014) support the use of questionnaires for survey-based research, adding that surveys are typically conducted to achieve primary data. This method, as noted by Torchiano et al. (2017) received considerable attention in practice and research, for years being applied as a tool to

systematically analyse experiences, opinions and expectations among the populations investigated. Survey creates a platform on which to observe the research from outside, and does not involve an active mediation component when compared with experiment or lab work where one or more elements are utilised and controlled (Torchiano et al. 2017; Suzuki and Pheng 2019)

In this study, questionnaire surveys were considered beneficial for the collection of data to comprehend the causes of abandonment and the impact of the factors contributing to the abandonment. Survey will also be used during the validation of the TOPSIS Model (TOPMod).

3.5.4 Case studies

Case study, as identified by Ebneyamini and Moghadam (2018), is an empirical investigation that studies a contemporary fact surrounded by its real-life perspective, particularly when the boundaries between the context and the object of study are not evidently clear.

Odoh and Chinedum (2014) defined case study as the background, environmental interaction, current condition, communities, groups, institutions, or businesses examined, documented, and analysed, for phases of patterns relative to external or internal influences. According to Ogolo (2019), case study method potentially provides a deep understanding of one case which is also applied to explicate and comprehend the occurrence of other cases.

The qualitative case study expounded by Rashid et al. (2019) supports researchers when conducting an in-depth investigation of convoluted phenomena within certain contexts. This method is the most broadly used in academic circles for researchers interested in qualitative research (Bas-karada 2014). Case studies permit explanatory (inductive) as well as confirmatory (deductive) findings and can also be based on single or multiple cases and can also include quantitative and/or qualitative data (Bas-karada 2014).

The two types of case study discussed by Odoh and Chinedum (2014) are i) intensive interview and ii) observation. The intensive interview can be either standardized or structured, non-scheduled, or semi-structured and unstructured (Bas-karada 2014). In the standardised or structured form, all the questions are asked in the same manner and order. On the other hand, the same questions may be asked, but not in the same order in the non-scheduled or semi-structured. In the semi-structured, relevant questions may be asked depending on the participants responses to previous questions (Odoh and Chinedum 2014). Young et al. (2016) opined that a semi-structured interview consumes more time than structured, and also requires skillful training. The other different structures of interview are presented in Figure 3.5.

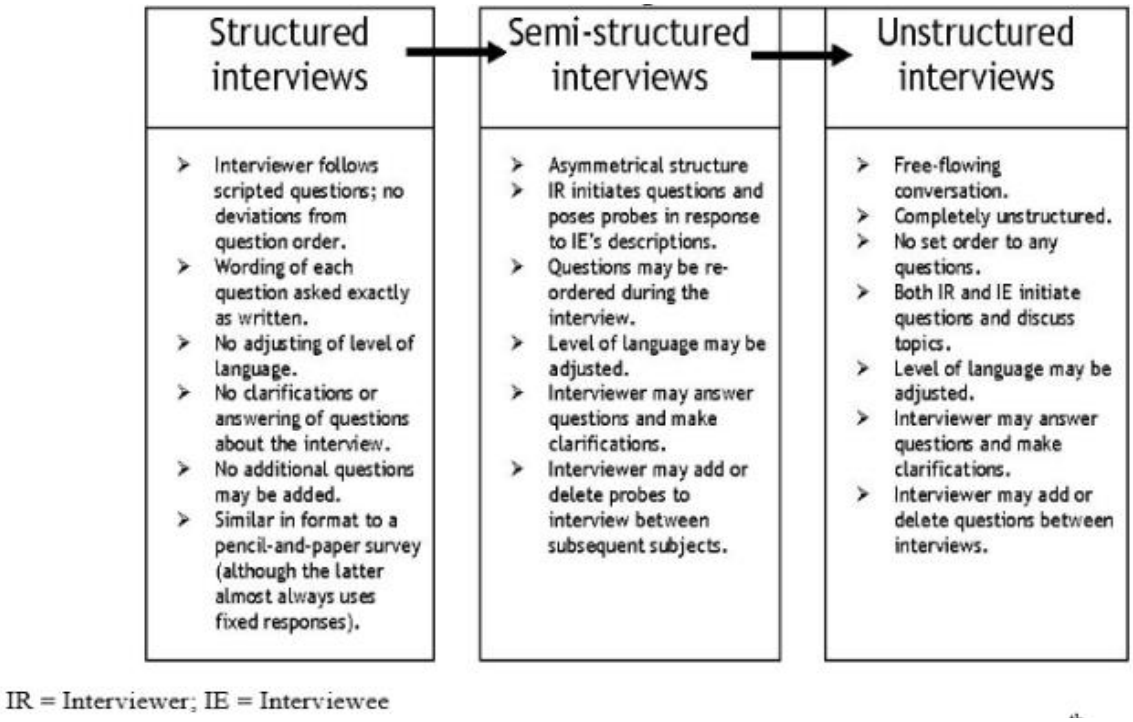


Figure 3. 5 : Different structures of interviews with characteristics

Source: (Nugraha 2015).

Case study can be conducted as a multiple case, or a single case as applied by Yin (2018). Multiple case study could entail analysis of multiple units or phenomenon, while a single case study is for the analysis of a single unit. Multiple case study, as identified by Saunders et al. (2019), could result in replication of a phenomenon in contrast to single case study that presents a critical or unique case study of a phenomenon under investigation.

With all the attributes identified in the review of this case studies method, this method is suitable and will be considered within this research. The Federal Secretariat building will also be considered as a single case study in the context of this research of a public infrastructure building as defined in section 2.4.

3.6 Research Approach (Data Collection and Analysis)

The research approach involves reviews of qualitative, quantitative, and mixed methods. The publications reviewed in this study adopted a questionnaire survey for data collection, except Dim and Ezeabasili (2015) that employed a mixed method. To further a detailed and extensive study on the root causes of abandoned infrastructure and possible remedies, the aim, objectives, and the research questions for this study were considered and it was determined that mixed methods (Please refer to discussion in session 3.2.1.5 and Figure 3.6) would be most appropriate. This would also help ascertain the reliability and the quality of information for this research. This is worthy of note that the mixed methods of quantitative (Study One and Two) and qualitative (Study Three) adopted within this chapter are segmented into three studies as highlighted in Figure 3.6 and subsequent sections.

Part of the benefit of mixed methods, as identified by Regnault et al. (2018), is that the method permits research questions to be studied from different perspectives, and for the relevant weaknesses and strengths of each method to augment the other. For instance, Hamma- Adama (2020) adopted mixed method to develop a framework for macro building information modelling (BIM) adoption in Nigeria,

while Iheukwumere (2022) applied the mixed method for the analysis of the performance challenges affecting the state-owned refineries in Nigeria. The adoption of a mixed method in both studies enhanced the development of a robust and in-depth knowledge of the research problems, supported by the identification of possible applicable solutions.

In this regard, this research utilised the application of questionnaires and interviews (mixed methods) for the collection of data and analysis. A follow-up qualitative study (semi-structured interview) will be conducted after the analysis of the Study Two questionnaire survey. In effect, Figure 3.6 represents the primary data collection and analysis components of the complete research plan.

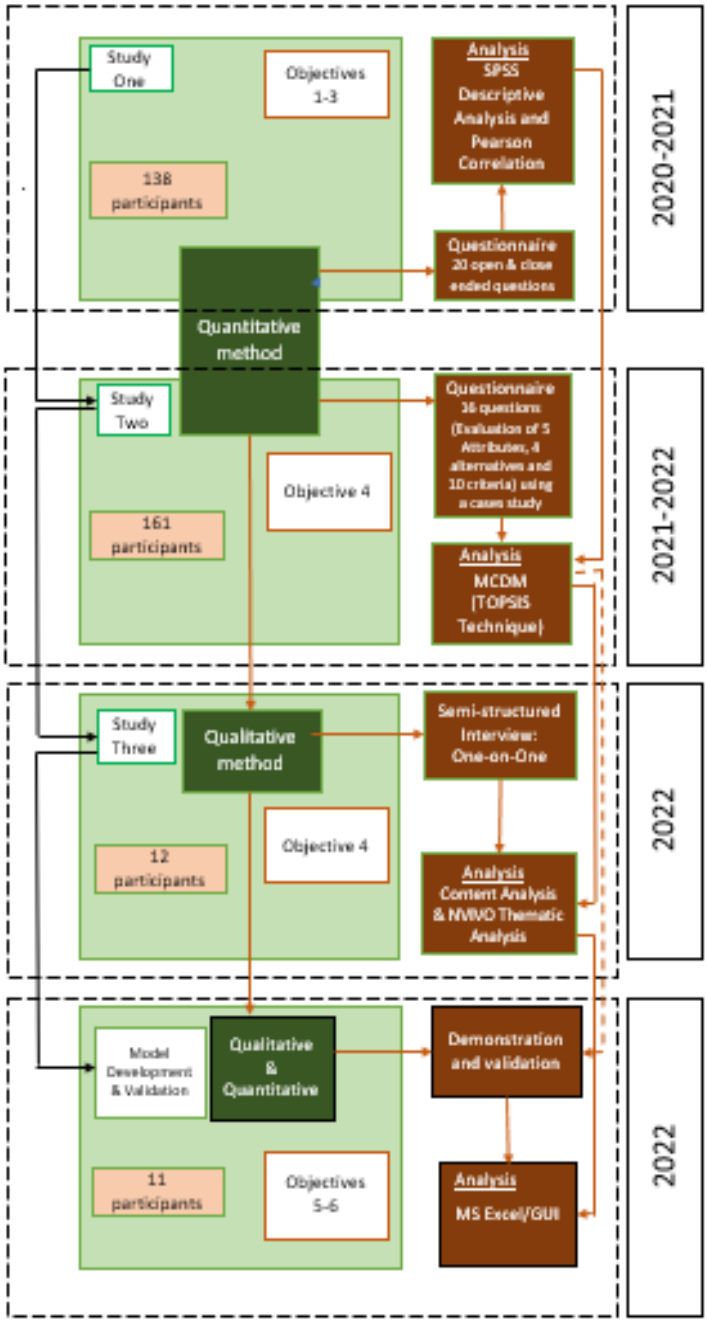


Figure 3. 6 : The design of the Primary Data collection.

3.7 Questionnaires

Kabir (2016) defined a questionnaire (design indicated in Figure 3.7) as a research instrument that consists of a succession of questions and other prompts for the intention of data gathering or hypothesis testing from participants. The questions are placed in a definite order (Sreejesh 2014). During the design of the survey, it is necessary for the questionnaire to be easy to understand, easy to be completed by the participants, and able to depict information that will accomplish the research objectives. Classic examples of questionnaires achieving the research objectives can be seen from the Zohrabi (2013); NCJRS (2017); and Vietkap Team (2021) studies. Notwithstanding, Rowley (2014) noted some important decisions to be implemented during the questionnaire designs:

- Checking the questionnaire for completeness to discard any question that are inadequately completed – missing data.
- Inputting data into selected data analysis software. E.g, SPSS, NVIVO.
- Cleaning and checking the data set.
- Comprehending the nature of the data.

Sheard (2018) and Eionla and Alvesson (2020) considered questionnaires with numerical rating elements as one of the quantitative methods used in survey research. Questionnaires may be administered individually or in groups and can also be self-administered or administered by an expert, with the instruments usually including a series of elements reflecting the aim(s) of the study (Ponto 2015). This instrument may be delivered in paper form to the participants or electronically through email or an internet-based program such as Google Form, SurveyMonkey, or a combination of both allowing the participants to select which approach is desirable. Sue and Ritter (2015) also supported electronic delivery, email, mail, and web pages as a means of access to questionnaires by participants.

The two types of questionnaires are open-ended and close-ended. Open ended provides opportunity for the participants to express their opinion in a free-flowing way, while the close-ended contain multiple choice answers which restrict the respondents to choosing from those answers provided (Kabir 2016). Sue and Ritter (2015) emphasised the importance of a questionnaire as one component of a procedure that commences with defining the objectives, then proceeds to data analysis followed by results reporting. Roller et al. (2016) adopted a 5-point Likert scale questionnaire in the electronic survey forwarded to experts while Sabri et al. (2019) adopted 6-point Likert scale for evaluation on advisory system (See Section 3.8.2.4 for more discussion on the Likert Scale).

To ensure homogeneity of the sample population in Study One, 76% of the participants will be from the South – West location of Nigeria where the The Federal Government Secretariat is located. For Study Two, 82% of the participants will be from built environment with the remaining 18% from allied industries. Combining the samples for Study One and Two for analysis is beneficial for the thesis. Homogeneity underpins determination whether the population is homogenous or not (Widyaningrum et al. 2020). According to CAAF (2023), homogeneous samples might share the same location, employment, or age and the more homogeneous the population, the more the validity of the conclusion from a sample.

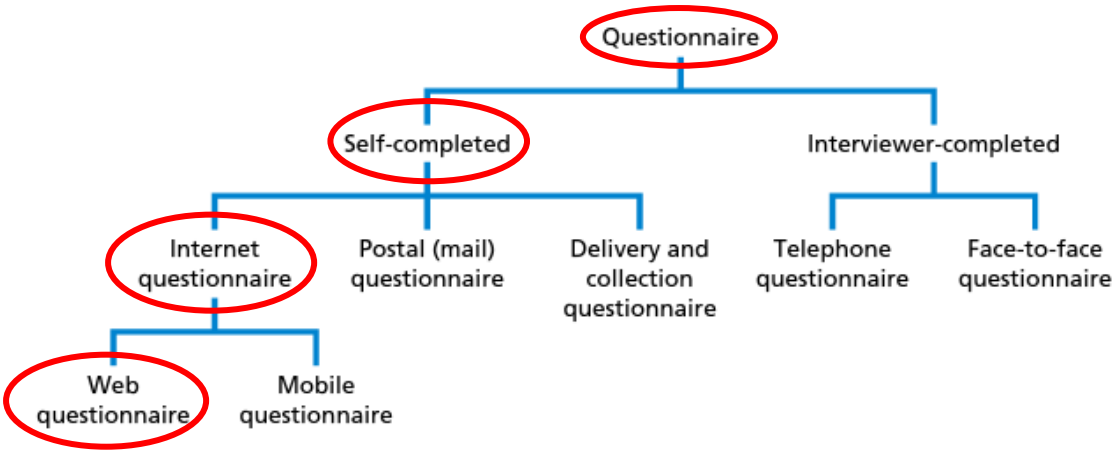


Figure 3. 7 : Questionnaire design

Adapted from Saunders et al. (2016)

Based on the literature review, Table 3.6 presents questions proposed for development into questionnaires to inform the data collection. These answers will be analysed with SPSS frequency descriptive analysis and Pearson Correlation in Chapter 4, Section 4.1.2 and 4.1.5.

3.8. Study One, Two and Three

The section presents the three studies conducted within this research to explore the quantitative, qualitative, and mixed method of data collection. The analytical tool deployed for each study was also examined. In addition to that, the set of questions as instrument for both the Study One and Study Two questionnaires and Study Three interview questions were presented in tables within the sub sections.

3.8.1 Study One: collation of variables

To achieve the objectives of this research with the adoption of the sequential explanatory mixed method, Study One (Quantitative) will be comprise of a questionnaire to identify the causes and the impact of abandoned infrastructure in Nigeria from the professionals' perspective (proposed questions presented in Table 3.5). The online questionnaire will be designed to ascertain the sustainability of abandoned infrastructure buildings and facilitate consideration of technological tools for sustainable procurement. The questionnaire will consist of 20 combined open/close ended questions compartmentalised into general information and abandoned projects.

The period of this data collection was at the commencement of COVID 19 Pandemic (See Section 4.1). The lockdown and change of operations within the university from face-to-face to online delivery presented its own challenges, with academics trying to adapt to the new COVID situation. The challenges include the inability to effectively contact colleagues to pilot the instrument at the beginning of the lockdown. For instance, Byrom (2020) found out that more than 75% of the research respondents encountered a negative effect of the lockdown on the capability to obtain data collection, engage in discussion with colleagues and circulate research findings. Others with distress, loneliness, poor mental well-being, physical disability, or long-term illness also found it challenging to operate from home.

The flow chart of the process in Study One is highlighted in Figure 3.8

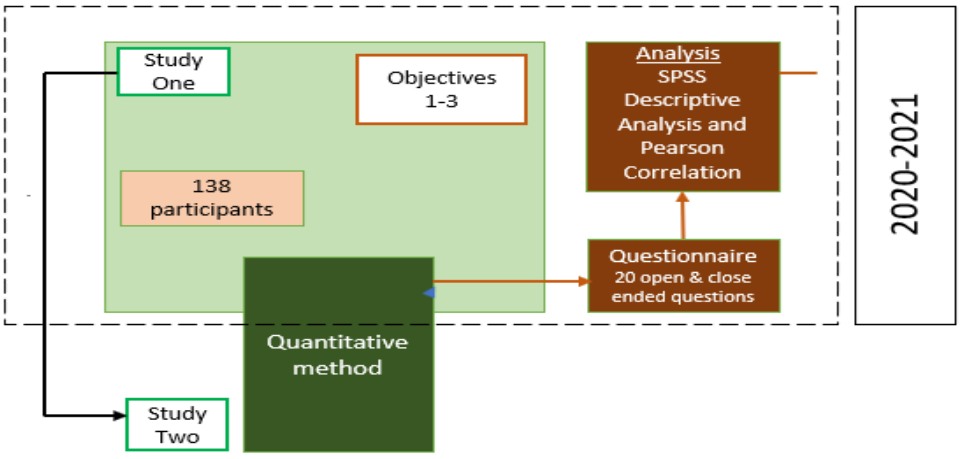


Figure 3. 8 : Study One Flow Chart

Table 3. 5 : List of Questions in the Questionnaire for Study One (Appendix 1)

N	Questions	Objectives	Relevance to Research Objectives	General Information	Authors
1	Profession		This will ensure that the participants selection is appropriate for data collection processes	Demography	
2	Years of experience in the industry				
3	Category of Industry				
4	Which part of Nigeria are you located (Sub geographical zone)?				
5	Which form of contract do you use mostly in your organisation?	2 & 3	These sets of questions served as bases of enquiry into the cause of abandonment and the impact as stated in Objectives two and three.	Abandoned Projects	Ekele et al. (2022) Elijah and Olumuyiwa (2011); Okafor et.al.(2018); Okereke (2017) Scales (2013); Hoe (2013); Tijan and Ajagbe (2016)
6	Have you been involved in construction projects that failed and were subsequently abandoned?				
7	What do you think of abandoned infrastructure buildings in Nigeria?				
8	If you have been involved in abandoned projects, could you please state the cause(s) for such project failure?				
9	In your opinion, what do you think is the impact of abandoned Infrastructure in Nigeria?				
10	As a professional, what do you think is the remedy for abandoned projects in Nigeria				
11	What are the main procurement methods adopted in Nigeria that you may have used in the past?	2&3	In addition to the Objectives two and three questions above, some literature suggests the application of tools to drive	Procurements Methods	Oyewobi et. al. (2017); Dim and Ezeabasili (2015); Amade et al. 2015 Ezenekwe and Uzonwanne
12	What are the main procurement methods adopted in abandoned infrastructure that you may have worked with in the past?				
13	Any idea of technological tools that we can use to drive sustainable procurement of infrastructure in Nigeria?				

14	Have you had to considered/utilised the tool mentioned above during any stage of your projects?		sustainable procurement. This will form part of the enquiry during the data collection.		(2017); Okafor et.al. (2018)
15	The Procurement Act of 2007 in Nigeria does not address sustainable development. What are some of the changes that you would like to propose to bring into current realities of global sustainability?	2 & 3			
16	Are you aware of the application of BIM and gBIM?		gBIM was specifically identified as a tool to address abandoned infrastructure. These sets of questions laid the platform for objective four in finding solution to the abandonment	gBIM	Araszkiewicz (2016); Lassen and Merschbrock (2016), Liu and Wang (2022); Cao et al. (2022); Edwards et al. (2019)
17	If you are aware of BIM or gBIM, have you used either or both of them in any of the projects that you are involved with?				
18	This research recommends the application of Green Building Information Modelling (gBIM) and Management in procurement of Infrastructure projects in Nigeria as a sustainable tool to enhance the successful completion of construction projects from design to construction, operation, demolition, and deconstruction (instead of abandonment). To what extent do you agree with this recommendation				
19	If you are interested in this study and its results, please provide a valid email address				

3.8.1.1 Analysis of Questionnaire Data.

The data to be obtained from the questionnaire is quantitative in characteristic. SPSS software will be utilised to analyse the data obtained. SPSS frequency descriptive analysis will be used to determine the causes and the impact of abandonment. The participants will also be asked to select their preferred remedy for abandoned projects from four multiple options provided in the questionnaire. In addition to the use of frequency descriptive analysis, SPSS Pearson Correlation will also be employed to comprehend the relation among the four variables in Section 4.1.5. Rahman and Muktadir (2021) noted the difficulty experienced in editing the output from SPSS as against MS Excel. However, the tool will enable in-depth understanding of the statistical and significant relationships among the variables by the researcher.

Faria et al. (2022) maintained that there is no precise definition of the Pearson Correlation. However, Nettleton (2014); Berman (2016); Kotu and Deshpande (2019) and Williams et al. (2020) defined the Pearson Correlation method as the most common approach to utilise for numerical variables by assigning a value between +1 and -1, with 0 signifying correlation, +1 as total positive correlation and -1 as total negative correlation.

Pallant (2016) stated that correlational techniques are often utilised by researchers involved in "non-experimental" research schemes. Disparate to experimental design, variables are not purposely controlled or manipulated, rather variables are defined as they naturally exist. Hence, the correlation enhances the exploration of the relationship between pairs of variables, and also predicts scores on one variable from scores on an alternative variable.

For instance, SPSS Pearson Correlation was applied by Contreras et al. (2013), and Maryrose and Mbeledogu (2014) to conduct research on "spatial connectivity as a recovery process indicator". With this, Roni and Djajadikerta (2021) suggested that the sample size will usually be large if conducting and estimating a correlation between two variables that is identified to have a small effect; it is a weak correlation. The responses to one of the close-ended questions in Study One "As a professional, what do you think is the remedy for abandoned projects in Nigeria" will be presented as variables. Hence, to recognise and analyse the statistical relationship amongst the four variables (designing with deconstructability in mind, refurbishment of abandonment projects, using an innovative management tool, and changing procurement methods), the Pearson Correlation technique will be adopted (see Chapter 4).

3.8.2 Study Two: Evaluation of Alternatives and Criteria (Sustainability)

With the redevelopment of an abandoned structure, the consideration (in this research) is for the solution to be sustainability driven. Following the literature reviewed in Chapter 2, Section 2.6, there was a need to conduct Study Two, and configure the questions to take cognizance of all the attributes (social, economic, environment, political, technical - SEEPT), alternatives and criteria mentioned in section 2.6. At the completion of Study One, Study Two will commence with another distribution of questionnaires to professionals in both built environment and allied industries.

At the time of data collection, between June and September 2021, the lockdown was already eased, the University resumed operations in January 2021 and online interaction had improved (Institute of Government Analysis 2021). With this, the researcher conducted a pilot study for Study Two. This is simply a precaution to be sure that the proposed study (sustainability consideration) will work.

According to Lowe (2019) A pilot study is a small viability study planned to test several aspects of the procedure planned for a larger or confirmatory investigation.

The pilot study provides a preliminary empirical result of a survey conducted. The questionnaire with the list of piloted questions is presented in Table 3.6. Figure 3.9 illustrates the flow of the process to be applied in Study Two.

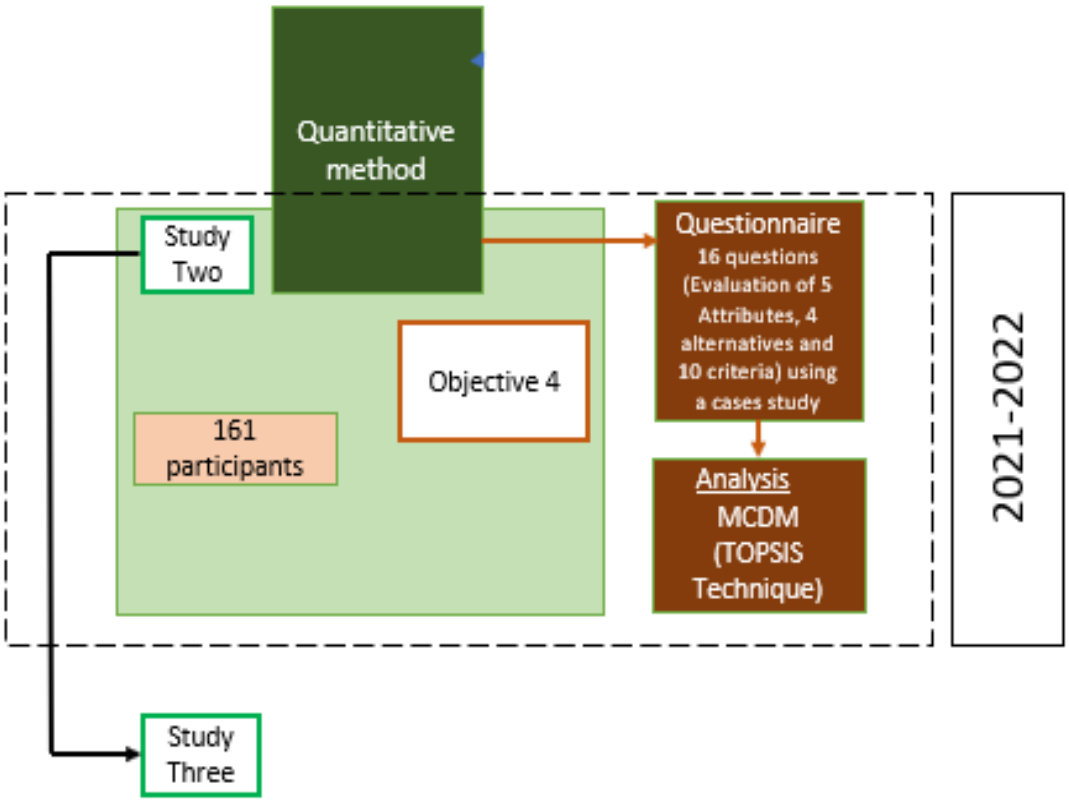


Figure 3. 9 : Study Two Flow Chart.

Source: Author Generated

Following completion of the analysis of the findings from the pilot study, Study Two will be designed to address the sustainable redevelopment of abandoned infrastructure to further evaluate the findings from the literature review and Study One. These answers will be analysed with the use of TOPSIS in Chapter 4, Section 4.2.6. The list of questions for Study Two is presented in Table 3.6.

Figure 3.10 displays the conceptual framework for Study Two. Phase 1 includes a literature review of articles capturing global view of abandoned infrastructure, and sustainability in the Nigerian context, evaluation of criteria and alternatives applicable to sustainable development.

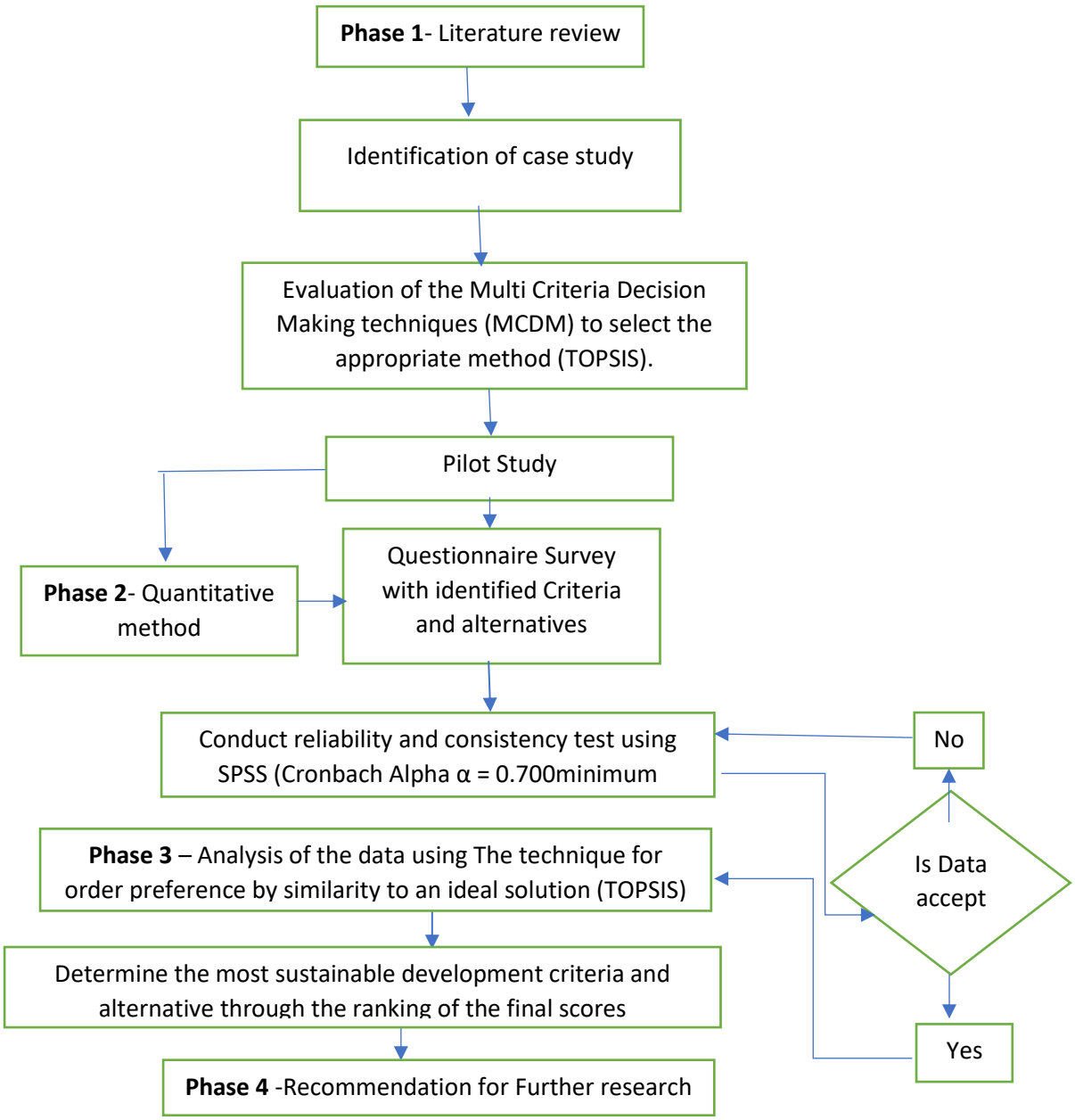


Figure 3. 10 : Conceptual Framework (TOPSIS)

Source: Author generated from (Ogunnusi et al. 2023)

3.8.2.1 Case study of a Public Building

A case study using a public building (discussed in Section 2.4) is presented in this section as a means to investigate and appreciate how the proposed (MCDM) approach can function with an actual building (Pavlovskis et al. 2017). The Federal Government Secretariat (Figure 2.10), in Lagos State as considered for this purpose is among the array of public office buildings abandoned due to relocation of the seat of the Federal Government of Nigeria from Lagos State to the Federal Capital Territory (FCT) Abuja in 1991 (Wahab 2020).

Ayeyemi (2021) and Nwannekanma and Gbonegun (2019) estimated the value of the abandoned 12-storey building complex at N72 billion (£128million) with the suggestion that, if reformed into luxury apartments, it could generate income through sales for the Federal government. Hence, the necessity arose to evaluate this abandoned building and develop a model that includes the selection of the best alternative through the application of MCDM TOPSIS method.

Case Study - Federal Secretariat - Alausa, Lagos, Nigeria (Source: Ayeyemi 2022)

Table 3. 6 : List of Questions in the Questionnaire for Study Two (Appendix 2)

N	Questions	Objectives	Relevance to Research Objectives	General Information	Authors
1	Profession				
2	Years of Experience		This will ensure that the participants selection is appropriate for data collection processes		
3	Academic qualification (tick the highest that applies)				
4	In which part of Nigeria are you located?				
5	Which sector do you operate in?				
6	What is the level of your awareness of abandoned structures in Nigeria?	2	These relates to Objective Two. That is, the participants would mention the abandoned structure that they are aware of.	Background – Abandoned projects	Tables 2.3&2.4
7	Please list the abandoned infrastructure (government or private projects) which you are personally familiar with in Nigeria (e.g., Federal Secretariat - Government projects)				
8	Please indicate your own level of awareness of sustainability issues in the context of environmental, economic, technological, social, and political dimensions.	1	Their level of awareness will also justify the responses required in Objective One in addition to findings from literature review	Sustainability Consideration	Pavlovskis et al., (2017); Vizzarri, (2020); Mcguinn et al., (2020), Section 2.6
9	How can the abandoned National Provident Fund Building, Badagry Way- Lagos/Nigeria, be redeveloped in the most sustainable way?	4 & 5	To understand the optimum sustainable solution for Objectives four and five requires the application of the MCDM TOPSIS technique. These set of questions enabled the data collection and the analysis in this context.		
10	How can the abandoned Federal Secretariat, Lagos State, Nigeria be redeveloped in the most sustainable way				
11	How relevant would you consider the following factors while refurbishing or maintaining the original buildings (Refer to Q9 & Q10) for their historical purposes?				
12	How relevant would you consider the following factors, while converting the buildings (Refer to Q9 & Q10) into apartment housing and preserving their architectural-urban expression?				
13	How relevant would you consider the following factors, for the demolition of any of the buildings (Refer to Q9 & Q10) and the implementation of a new design?				
14	How relevant would you consider the following factors, with (Partial or outright sale to private sector/ entities or investors)				

	these buildings (Refer to Q9 & Q10) to private sector / entities or investors?		
15	What do you feel would be the best way (with sustainability in mind) to address the abandonment of infrastructure in Nigeria?	5	This question created a platform for further clarification of addressing the abandonment with sustainability in mind for objective five.
16	As this is an ongoing research study, please provide your name and/or a valid email address if you might be interested in participating in later stages.		

3.8.2.2 Multi Criteria Decision Making (MCDM)

The selection of the most sustainable development option of abandoned projects is essential for the realisation of sustainable development goals in Nigeria. Hence the MCDM consideration as discussed in Chapter 2.

MCDM tools also referred to as Multi Criteria Decision Analysis (MCDA) by Mota et al. (2013) Taherdoost and Madanchian (2022) are further subdivided into Multi - Objective Decision Making (MODM) or Multi – Attribute Decision Making (MADM). According to Aziz et al. (2016) and Zavadskas et al. (2018), the subdivision of MODM and MADM are types of MCDM method. MODM concentrates on continuous decision spaces with an unlimited number of alternatives and no clear goal, while MADM focuses on finite numbers and explicitly known decision making alternatives with clear criteria, goals, and attributes (Taherdoost and Madanchian 2022). Kabir and Hasin (2012) and Vommi (2017) also affirm that MADM deals with the challenges of selecting an option from a set of alternatives that are characterized in terms of their attributes. MADM (TOPSIS) was also Kassam and Fareed (2020)'s preference when compared with MODM.

Ghorpade and Vasatkar (2015); and Chakraborty and Chatterjee (2013) asserted that Multi Criteria Decision Making (MCDM) techniques enhance the selection of the optimum alternatives in situations where there are multiple criteria, with their number typically limited to "*seven plus or minus two*". The optimum criteria can be obtained by analysing the diverse scope for the criteria, weight for the criteria and select the optimal one using any of the MCDM techniques (Aruldoss et al., 2013; Ghorpade & Vasatkar 2015). Suitable decisions identified by Tan et al. (2021) are those centered on information where poor-quality information unavoidably leads to poor decision making. Tan et al. (2021) acknowledged that MCDM has demonstrated its capacity to integrate multi-stakeholder value and technical information in BIM-based processes for decision making. It relates and ranks decision-making systems by integrating element and often conflicting pointers from all information resources into a sole overall pointer.

In our everyday life, we are faced with many decisions based on diverse criteria. Decisions can be made by providing weights to diverse criteria and the weights can be acquired as discussed in Section 2.6.4. It is necessary to determine the configuration of the problems and obviously assess multiple relevant criteria. Preferred solutions could mean selecting the most preferred alternative from a set of alternatives, or selecting a small set of good alternatives, or 'grouping alternatives into different preference sets'(Aruldoss et al. 2013 p. 31.)

With the use of technology such as BIM, MCDM, and gBIM to address the abandoned infrastructure issues, as suggested in some literature in Section 2.5 BIM or gBIM can be considered as a method if one of the alternatives (e.g retrofitting or refurbishment) has been selected. Additionally, BIM for infrastructure identified as I-BIM, due to its strong potential in terms of technological and economic benefits could also be considered for refurbishment purposes (Biancardo et al. 2023). However, with consideration of multiple alternatives in Session 2.6.1 and literature reviewed in Session 2.6, Multi Criteria Decision Making (MCDM) technique will be deployed in this context in terms of sustainable development to support appropriate selection / identification of the most effective decisions of the array of alternatives identified in section 2.6.1 (Pavlovskis et al. 2017). Figure 3.11 illustrates the hierarchical view of different MCDM Techniques and its types.

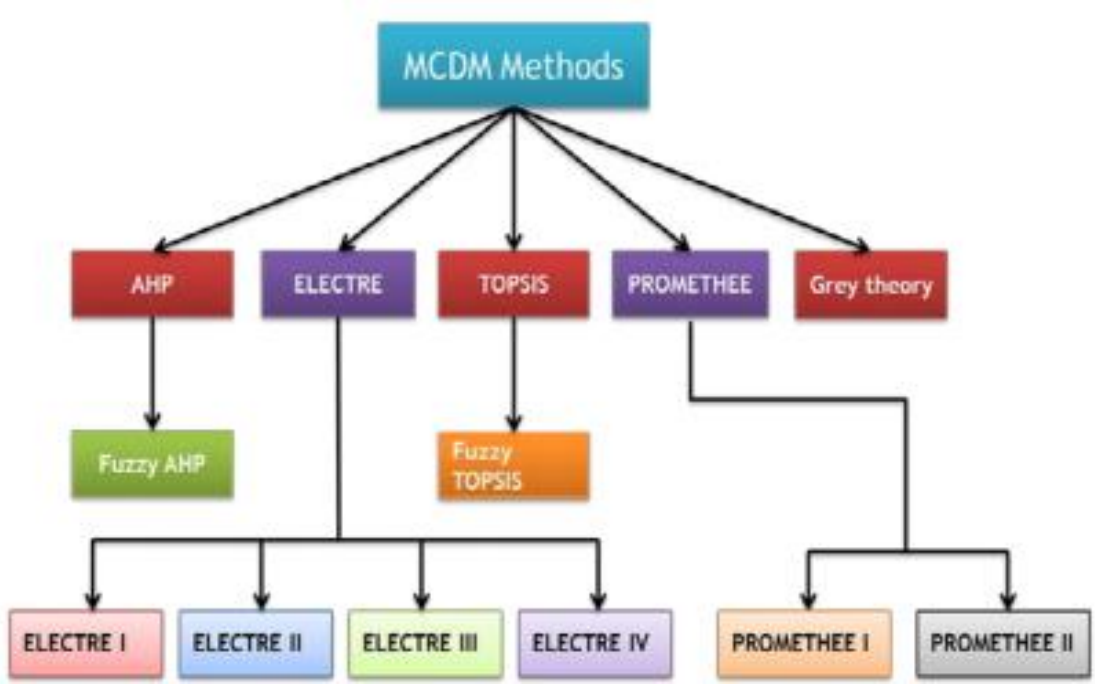


Figure 3. 11 : Hierarchical structure of MCDM Methods.

Source: Ghorpade and Vasatkar (2015); Aruldoss et al., (2013)

3.8.2.3 The Relationship of MCDM Techniques

To confront demanding decision making, researchers have generated diverse MCDM techniques (Kabir et al. 2014; Feizabadi et al. 2017; Taherdoost and Madanchian 2022; Mousavi et al. 2022). Literature reviewed by Tan et al. (2021) either used these techniques as an individual (single) approach or as hybrid (multiple) approaches for providing a solution. Table 3.7 presents the relevant MCDM acronyms for all the techniques, their classification, and the relevant authors.

Table 3. 7 : The relationship of MCDM Techniques

MCDM Acronyms	Definition	Classification (Approach)	Description	References
TOPSIS	The Technique for Order Preference By Similarity to an Ideal Solution	Single	TOPSIS is one of the valuable Multi Criteria Decision Making techniques that are very easy and simple to execute on relatively large - scale data, so that it is applied when the researcher prefers an easier weighting method	Kabir & Hasin 2012
AHP	Analytical Hierarchical Process	Single	AHP leverage on pairwise comparisons to develop the priority scales of composite criteria	(Ahmad and Thaheem 2018)

			and constrains founded on linear algebra	
AHP + TOPSIS		Hybrid	This hybrid can be applied to rank the potential alternatives as the TOPSIS can itemize and identify alternatives with regards to the reality condition while AHP can methodically weight the decision criteria.	(Alireza et al. 2017)
Fuzzy+ TOPSIS		Hybrid	Fuzzy TOPSIS permits the vague quantitative and qualitative information transformation into quantifiable equivalents helping decision makers to proffer solution to real life issues more precisely	(Fazeli et al. 2019)
AHP + MAUT	Multi Attribute Utility Theory	Hybrid	AHP and MAUT integration can be used to evaluate the momentous influence of the identified main and sub-criteria on the selection procedure	(Alshamrani et al. 2018)
Fuzzy + PROMETHEE	Preference Ranking Organisation Method for Enriching of Evaluation	Hybrid	Fuzzy and PROMETHEE integration can obtain the more crucial out of the existing information and make impartial decision devoid of copious subjective data	(Gul et al. 2018)

Source: Adapted by author from several publications as denoted in the table.

Emovon and Oghenenyerovwho (2020); Aruldoss et al. (2013); listed the various types of MCDM methods including their advantages and disadvantages (Table 3.8). For instance, some of the disadvantages of the method known as Elimination and Choice Translating REality (ELECTRE), such as "being time consuming" and Grey Theory as "not providing optimal solution", made the two types inappropriate for the analysis within this study.

Balioti et al. (2018) identified the analytical hierarchy process (AHP) for "decomposing a complex MCDM problem into a system of hierarchies". More so, AHP can be considered defective on a reason of excessive measure of repetition in correlations (Karthikeyan et al. 2016). Another drawback of AHP pointed out by Oguztimur (2015) is its subjective nature of the modeling process, meaning that, the decision obtained may not be valid from the methodology adopted. However, to ascertain the optimum selection process for decision makers with regards to infrastructure sustainability, TOPSIS was selected, as discussed in section 3.8.2.4. based on the nature and the flexibility of the data.

TOPSIS will be applied to consider all the attributes and factors related to abandonment and its possible remedies based on the findings from the pilot study and the literature review. The TOPSIS

method presumes that each criterion has a propensity of repetitively decreasing or increasing utility which leads to clearly defining the positive and negative model solutions. To evaluate the relative closeness of the options, the Euclidean distance approach defined by Segundo et al. (2017) as the ”square root of the sum of the squares of the differences between the corresponding coordinates of two points” can be applied to assess the comparative closeness of the alternatives to the ideal solution to obtain best alternative (Ghorpade & Vasatkar 2015; Vommi 2017).

Table 3. 8 : MCDM techniques with advantages and disadvantages

MCDM method	Principle of decision making	Merits	Demerits
AHP	Optimum solution is obtained based on the degree of importance of criteria and alternatives. The problem is generally structured in hierarchical format before solution is sort.	It does not require additional tool for criteria weight determination	The technique becomes more complicated as criteria and alternatives increases
TOPSIS	The technique evaluates the optimum alternative by applying distances to positive and negative solution	The process is quite simple and the solution procedure does not change irrespective of number of decision criteria and alternatives	The correlation between criteria are not considered in the evaluation of Euclidean distance. In addition, vector normalisation may be required in solving problem that are multi-dimensional
PROMETHEE	The tool is an outranking methodology and it solve a decision problem on the basis of comparing alternatives while considering the alternatives deviation with reference to decision criteria	The process does not require score normalisation	Criteria weights need to be evaluated with different tool. Additionally, Preference function need to be defined
ELECTRE	ELECTRE method develop solution based on defining outranking relationship between two alternatives at a time. Some of the variant of the tool are ELECTRE I and II	The technique can provide solution even when there are missing data	In the absence of software, technique is computationally difficult due to complex evaluation procedures involves
VIKOR	The technique determines optimum solution by comparing alternatives with respect to measure of closeness to ideal alternative	Approach is an updated variety of TOPSIS	In the face of conflicting scenario, technique becomes challenging
Ashby	Chart provide means of appraising performance of alternatives by comparing ratio between materials properties. The best alternative is the one with the highest performance index	The approach is very valuable for initial materials screening	The approach is limited to three decision attributes
COPRAS	The technique utilises direct and proportional dependences of significance and utility degree of alternatives with respect to conflicting decision criteria to determine optimum solution	The method is simple and yet effective in solving material selection problem	It quite unstable as data variation may result to change in overall ranking

Source: Emovon and Oghenenyerovwho (2020)

3.8.2.4 Integration of TOPSIS

With the application of the TOPSIS principle is considered easy to perform and execute (Ghorpade & Vasatkar 2015).

The set of questions in the research instrument are required to obtain the viewpoint of the research participants, which will then be analysed based on the inclusion of a Likert scale structure within the questionnaire. Historically, Likert scale with the most popular scales of 1-5 and 1-7 was initiated by Likert in 1932 (Tutz 2021). Balioti et al. (2018) adopted a scale 1 to 10 for MCDM application in spillway selection for a dam construction in Northern Greece, while Omotayo et al. (2020) explored a scale 1-5 for kaizen costing implementation in the construction industry. Chakrabartty (2019) apprised that each element in the Likert scale usually has an odd number of response classifications. Hence, Jahan et al. (2016) implemented the scale 1-5 in material selection to rate the corrosion resistivity of materials. Adil et al. (2019) also embraced a 5-point Likert scale questionnaire design for data collection. Amade (2015 p.69) validated the adoption of a Likert 5-point scale as being found to be "acceptable in most construction project management literature".

A Likert scale occasionally violates the numerical assumption theories necessary to assess them. However, the ability to interact the judgements and the experiences of the participants in the form of measured data led to being deemed appropriate in this context (Tutz 2021; Bishop and Herron 2015; Kaptein et al. 2010; and Jamieson 2004). On this basis, the 5-point scale was adopted for this study (Table 3.9).

Table 3. 9 : Interpretation of the fundamental scale of absolute number

Scale	Importance	Scale	Importance	Scale	Agreement
1	Not important	1	Equal Importance	1	Strongly agree
2	Important	3	Moderate Importance	2	Agree
3	Moderately important	5	Strong Importance	3	Neutral
4	Highly Important	6	Very Strong Importance	4	Disagree
5	Extremely Important	7	Extreme Importance	5	Strongly disagree
		2,4,6,8	Can be used to express the intermediate variable		

Source: Author Adapted from Omotayo et al. (2020) and Balioti et al. (2018)

Aruldoss et al. (2013) conducted a survey to discover opportunities for the application of MCDM for multiple choices situation such as performance evaluation, banking, safety assessment and other multi criteria domains. Roszkowska (2011) adopted a MCDM algorithm for crisp and interval data, while Rahim et al. (2018) considered this method for the selection of the best employee by management.

TOPSIS method is the MCDM method adopted and discussed by all these authors.

TOPSIS possesses a very transparent logic with low functioning complexity, and this is related to both quantitative and qualitative data (Zhao et al. 2022; Balioti et al. 2018). However, Zhao et al. (2022) argued that one of the drawbacks of the TOPSIS method is that it requires a combination of other method(s) to compute the values for non-quantitative problems. In this study, the qualitative problems will be analysed using NVIVO (Chapter 4).

3.8.2.5 The technique for order preference by similarity to an ideal solution (TOPSIS)

The calculation through the application of the TOPSIS principle is efficient to perform and execute (Ghorpade & Vasatkar 2015). Equation 1 displays the mathematical algorithm of TOPSIS, the alternative and the criteria.

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ . \\ . \\ . \\ A_m \end{array} \begin{array}{c} \begin{array}{cccccccc} C_1 & C_2 & C_3 & . & . & . & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & x_{13} & . & . & . & x_{1n} \\ x_{21} & x_{22} & x_{23} & . & . & . & x_{2n} \\ x_{31} & x_{32} & x_{33} & . & . & . & x_{3n} \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ x_{m1} & x_{m2} & x_{m3} & . & . & . & x_{mn} \end{bmatrix} \end{array}$$

Equation 1: (Source: Kabir and Hasin, 2012)

With reference to Equation 1, the MCDM challenge with (m) alternatives (A_1, A_2, A_3..... A_m) being appraised by (n) criteria (C_1, C_2, C_3……., C_n) can be experienced as a geometrical system with (m) points in (n) "dimensional space". A component x_{ij} of the matrix signposts the performance score of the *i*th alternative, A_i, regarding the *j*th criteria C_j.

The TOPSIS method presumes that each criterion possesses the tendency of uniformly decreasing or increasing utility, which results in easily defining the negative and positive ideal solutions. This can also be possible with the adoption of Odu's (2019) mean weight methods.

Kabir & Hasin (2012) adopted a hierarchy structure of four (4) levels: Goal, Attributes, Criteria and Alternatives. Figure 3.12 presents the main goal sequence for this study. Prior to the analysis of the data with TOPSIS, the average mean value (AMV) of each criterion from the participants would be

obtained (Wren et al. 2020; Wickramaarachchi et al. 2021). Odu's (2019) criteria weightage will be applied to calculate the mean weight for the criteria.

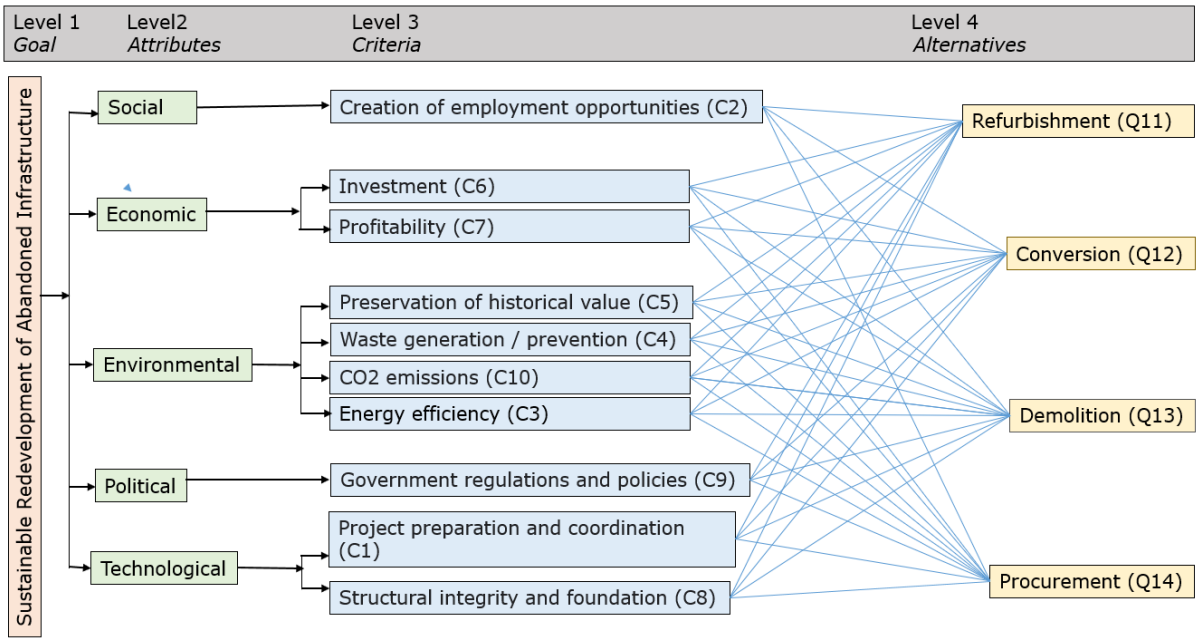


Figure 3. 12 : The main goal sequence for sustainability appraisal of the abandoned infrastructure redevelopment

Source: Author inspired by (Pavlovskis et al., (2017); Kabir & Hasin, (2012); Vizzarri (2020); Mcguinn et al., (2020); and Ogunnusi et al. (2022)

3.8.3 Study Three: Semi-Structured Interviews (One – On – One)

Jamshed (2014) considered the interview (Figure 3.13) as the most common design of qualitative research data collection, and confirmed that most of the qualitative research interviews are either in-depth structured or semi-structured (refer to Figure 3.5). An example of in-depth structure is the semi-structured interview where the participants answer open-ended pre-set questions.

Semi - structured interviews (SSI) can be used to probe an interviewee's thinking (Kearney et al. 2019; McKeown et al. 2016) with McKeown et al. (2016) adding that the semi- structured form also enables the clarification of themes and policies within the subject of discussion. Nguyen (2015) further revealed that common gestures such as direct looking into the eye during the SSI could provoke the chances of developing a good relationship with the interviewee. However, a limited or poor response could truncate the conversation, resulting in a sub-standard quality of the interview. The sub – standard quality may occur whenever the interviewer loses track of their thoughts or attempts to deduce the unintentional meaning from a dull discussion (Kakilla 2021). Some other disadvantages of SSI identified by Adam (2015) are being "labour intensive" and "time consuming".

Adams further stated that preparation for the interviews, which includes setting up, the overall organisation, and the analysis of the interview, is not as easy and quick as it might seem. According to DeJonckheere and Vaughn (2019), there is considerable time and effort required in ensuring a positive outcome of the exercise. This particular type of interview entails the demanding task of analysing a large size of notes with potentially many hours spent transcribing the interviews.

Pehrson et al. (2017) and Naess (2018) proposed that a semi-structured interview can enhance the identification of any alternative point of view when meaningful questions are being asked. That is, the data obtained from interview can be applicable for corroborating facts revealed through the review of literature or a questionnaire.

A follow-up, in-depth, qualitative study is required to validate the findings from the questionnaire in Study Two, hence it was reasonable to adopt the semi-structured interview (one-to-one, as highlighted in Figure 3.13) route to examine a selected pool of participants from the Study Two data collection. The selection choice will be based on purposive sampling method, with the criteria targeting highly experienced built environment professionals as participants in "*5 option categories*" (see Section 3.8.3.2).

Purposive sampling is an intentional and non-probability selection of participants base on their capability to make clear a concept, specific theme, or phenomenon (Robinson 2014 and Obilor 2023). Basically, the availability of the participants and willingness for participation as discussed in Section 4.1 was also another factor for consideration.

The researcher adopted the semi-structured interview to further comprehend how to address the possible solution to the abandonment with sustainability in mind.

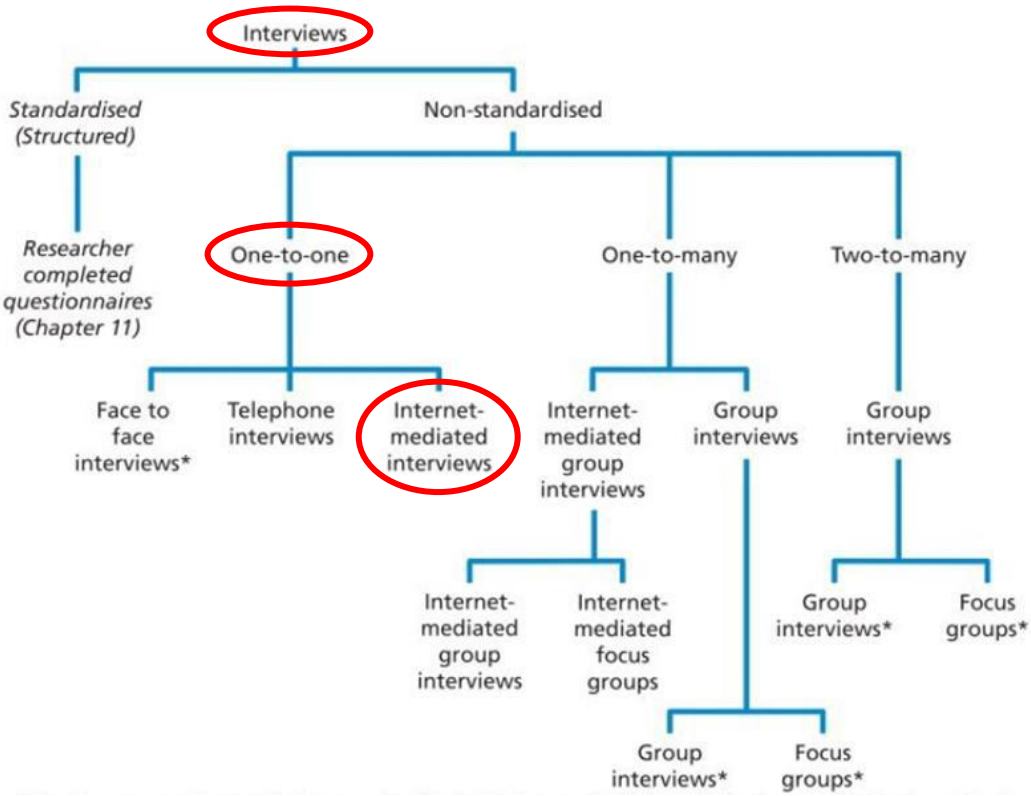


Figure 3. 13 : Interview structure

Source: Adapted from Saunders (2019)

3.8.3.1 Practical steps for Designing and Conducting the Semi-structured interview.

This section includes the selection and recruitment of the participants, an outline of the questions with the interview guide, the technique to be adopted for the interview, and the analyses of the gathered information.

The target group for the semi – structured interview are the relevant built environment professionals such as Architect, Engineer, Construction Project Manager, etc. The total potential respondent pools are anticipated to provide a large number of respondents (167 respondents were achieved in the previous stage of the research) requiring the researcher to select 16 participants using a purposive sample technique (See Section 3.8.3) based on years of experience, awareness of infrastructure abandonment in Nigeria, profession, sectors represented, response to some of the questions in the previous data collection (Questionnaire) and previous indication of interest to participate in the research.

The respondents will be identified, then invitations and a consent form will be emailed to them. The email also introduces the research, the aims and objectives**,** reconfirming their interest to participate in the research and also suggesting convenient date and time for the interview.

The approach to interviewing the participants will be flexible given the experiences from the prior data collection, where some of the respondents from the public sectors were unwilling to provide adequate responses as expected, or remained anonymous for fear of being reprimanded. To encourage more participation, 30-45 minutes was planned for the interview and the choices of dates and times were made very flexible for the participants.

The focus group and the one-on-one interview were considered in the context of this research. For instance, Karen et al. (2014); Tausch and Menold (2016) identified that "*aggressive or dominant persons may impact the group dynamics"* and "*challenges of assembly owing to time and location constraints"* as possible disadvantages of a focus group. The availability of the participants and gathering them together could also be a challenge. Instead of a focus group, a one-on-one interview (Figure 3.14) method will be adopted in the context of this research.

Hence, the best option will be to work with their timing including weekends and evenings which would not have been possible in a focus group. One of the participants was not even in Nigeria at the time of the interview but was in Canada - a different time zone from Nigeria and UK (See Section 3.8.3.2).

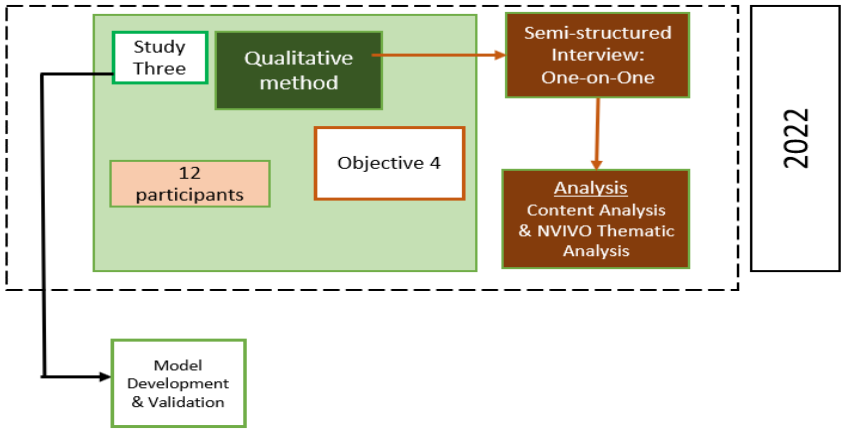


Figure 3. 14 : Study Three Flow Chart (Refer to Figure 3.6)

Schram (2014) stated that content analysis is generally embarked on when creating a valid and replicable inference from other meaningful matter or texts to the contexts of their application.

Hamma-Adama (2020); Hamma-Adama et al. (2018), Osobajo (2017), and Wilson (2013) adopted content analysis within their research, although their respective research focus was on differing issues, but the same methods were applied.

Seith (2011) evaluated content analysis but did not use it in their study. Seith believed that analyses with the application of coding is suitable for text-based data or unorganised data where a researcher has conceptual concerns about the research. Iheukwumere (2022) evaluated the analytical technique but did not apply it as the author considered it inappropriate due to it being overly reliant on counting and frequency for themes development. Therefore, Qualitative content analysis and thematic analysis will be adopted (Section 3.8.3.3) for the analyses of the semi-structured interview based on the findings from the data collection.

3.8.3.2 Drafting of the interview questions with the interview guide.

The questions were drafted, edited, updated and piloted (with three academics). There were no suggestions for alteration of the questions from the pilot but some advices from the academics was:

"*keep to the themes and look out for emerging themes, but in control not to digress, always come back*" - ARC.

"*It will be useful to remind your participants of the questions you initially asked them*. *Also, If possible*, *you may also remind them of their comments/answers and then ask why the answer so*.." - PM.

Commencing the main interview, the first question was a follow-up of the questions from Study Two data collection (Questionaire-survey). It was a closed-ended question (Table 3.6 / Appendix 2) with 5 options to serve as gateways to further open-ended inquiry. Based on their level of awareness of abandoned projects in Nigeria either they are determined as being *not aware*, *aware*, *well informed*, *witnessed* or *participated* in one or more. The closed-ended questions is quantitatively analysed in Chapter 4, Section 4.2.5. The participants who selected "*not aware*" as an option in Study Two were not considered for this qualitative study.

The question further states that they could share their knowledge, their experience or share a story about a project that they witnessed, and additional probing then ensued. There was an expectation that some issues not initially anticipated could arise, and in lieu of that, the sequence of the questions was rearranged and more questions were added to the subsequent interview guide. There will be flexibility for extension of time during the interview while interviewees will also be opportuned to decline any question. The researcher would also brief the interviewees on anonymity, confidentiality (Table 3.10) and manage any of their other expectations for effective interview sessions (Sim and Waterfield 2019).

After the first interview session, a review of the arrangement of the questions and other findings were taken to improve subsequent interviews.

Table 3. 10 : Interview questions for Study Three

Interview questions for Study three
1)Introductory Statement……. • Appreciation • Aim of the interview • Timing confirmation • Validation of the acceptance for the participation • Ethical consideration / Confidentiality • Demographic information – Profession, Years of experience, Sector….
2) From your response to (Q6) within the online survey, you are (for instance) "well- informed" about abandoned projects in Nigeria. Can you share your experience about these abandonments?
3) What are your thoughts about sustainable redevelopment?
4) Within the online survey, (Q15) You suggested that you felt "the best way (with sustainability in mind) to address the abandonment of infrastructure in Nigeria" was…….. Can you please explain your thinking behind this suggestion?
5) Were there any particular issues or criteria which you took into account? (e.g., finance, practicalities, impact)
6) Would the approach you suggest be used in other situations? e.g New Development.

Source: Author generated

Qualtitative Content Analysis

To address the waste management of abandoned infrastructure, qualitative content analysis will be employed by selecting from participants that mentioned or relates at least two of the 5Rs (rethink, reduce, reuse, refurbish and regulation) during the intervivew discussion. This will acertain the pattern of the participants responses. Schmidt and Hunter's (2015) view qualitative content analysis steps include:

To achieve the aim of this study Schmidt and Hunter's (2015) analytical method for conducting qualitative content analysis was adopted as presented below:

1- Identification of individual aspects related to the analysis by categorisation of the materials

2- Compilation of categories into themes for research questions or objectives

3- Breaking down of themes into smaller codes or nodes which contain comprehensive information relative to the research questions or objectives

4- The linking of coded information into cases and the interpretation of cases to provide meaning to the study.

3.8.3.3 Thematic Analysis

The intention of the interview is to explore in-depth knowledge of how to address abandonment with sustainability in mind. NVIVO 20 will be utilised to execute this thematic analysis of the results from the interview to recognize emerging themes from the responses provided by the participants. Scharp and Sanders (2019) classified the six steps of thematic analysis as:

1. Gaining familiarity with the data

2. Creating coding categories or subcategories
3. Generating themes
4. Reviewing themes
5. Labeling themes
6. Identifying exemplars

Thematic analysis and qualitative content analysis approach (adopted by Ogunnusi et al. 2022) will be selected to address the qualitative analysis of Study Three. Thematic analysis is a beneficial and flexible method which proffer a multi-dimensional narrative of the research data (Vaismoradi et al. 2013). Jordan (2019) also utilised NVIVO to examine the links between academics, online networking, institutional roles and identity trajectory.

Despite one of the NVIVO challenges identified by Stengel and Schutt (2016) as difficulty to learn the process of inputting the data into the computer system, Sharp et al. (2019) positively considered NVIVO as powerful and effectual for addressing sizable sets, as well as proffer robust understandings into qualitative data in a well-timed manner in comparison to humans.

Categorising the research findings into appropriate themes would require the combination of pre-identified themes and emergent themes to allow comparative analysis between themes (Bertone et al. 2018). Morgan and Nica (2020) considered pre-defined themes as being initially obtained from the literature by the researcher, while the emergent themes are those that emerged across the data collection. The combination of these two set of themes avoids prejudices, permitting the emergent themes to proffer some triangulation. Triangulation as noted by Patton (1999) and Nowell et al. (2017) enhances credibility and validity in research activity through the convergence of information from different sources . In view of this, pre-defined themes were those themes from literature reviewed (as presented in Chapter 2, Section 2.6.1.) that were coincidentally reffered to by the participants during the interview. The emergent themes are the new themes that emerged from the participants responses during the interview (See Chapter 4, Table 4.17).

3.8.4 Model Development beta testing and Validation

To further ensure the validity of the research, the proposed MCDM TOPSIS model will be developed (a User Guide will be provided), tested, and validated with the help of academia and built environment professionals (Figure 3.15). The model will undergo beta testing with the participants as a form of acceptance testing (with the users' feedback) to ascertain how the real user will interact with it (Hrzenjak 2023; Cser 2019).

Beta testing has been understood to be useful for testing software development as found from the publications in Table 3.11.

Table 3. 11 : Beta Testing publications

N	Publications.	Authors
1	An exploratory analysis of sport teaching in physical education	Pill (2017)
2	A large -scale comparative study of beta -testers and standard user: A comparative study of beta testers and standard users	Stavova et al. (2018)

3	The development of mobile phone App to support se-monitoring of emotional well-being: A mental health digital innovation	Rickard et al. (2016)
4	Beta testing in social work	Traube et al. (2017)
5	An empirical study of test generation with BETA	De-Matos et al. (2016)
6	A software component for Polygot Text-to-Speech Synthesis: User interface and Beta Testing results	Fogarassy-Neszly et al. (2015)
7	Development of mobile billing application system for PAMDES water meter data logging	Ahmad et al. (2022)

As Beta testing was expected to be coordinated in-house (with the real users) to ensure scalability and performance, functionality, the online location of the demonstration and testing of the model makes any in-house testing unachievable (Cser 2019). The model will be demonstrated to participant(s) individually (as was conducted during the one-on-one interview for Study Three). Therefore, for effective monitoring during the demonstration, the worksheets and the survey form will be completed by the researcher with the information provided by the participant(s). At the end of the validation, the researcher will also engage the participants in a structured interview to ascertain the potential relevance of the model within the built environment.

In addition to the Odu's (2019) mean weight criteria weightage, adopted in Study Four (Model demonstration and Validation), the Mohare's (2021) entropy weightage calculation will also be applied in the model. This was inspired as multiple criteria weightages were adopted by some literature in Figure 2.13.

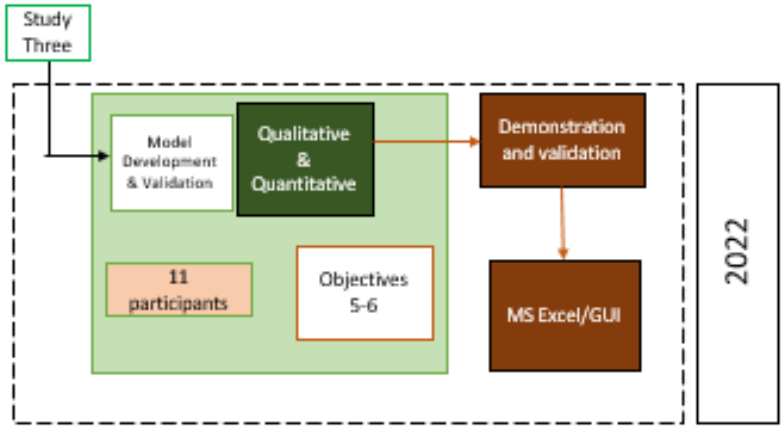


Figure 3. 15 : Model Development and Validation (Refer to figure 3.6)

3.9 Research validity and reliability

Usadolo (2017) expressed the imperativeness of validity and reliability in research. These terms express the integrity of the procedures adopted as well as the outcomes of the study. Ensuring research validity involves evaluating the suitability of the research design and the data collection methods for responding to the research questions (Bryman 2012).

Reliability enables the researcher to tap into the strength of both quantitative and qualitative approaches when using mixed - method (Usadolo 2017). According to Surucu and Maslakci (2020), reliability is a pointer of the consistency of the computed values attained in iterated measurements under consistent circumstances when applying the same measuring instrument. Surucu and Maslakci

emphasised that reliability is not only an aspect of the measuring instrument, but also an aspect of the outcomes of the measuring instrument. Reliability also implies the faith that can be acquired from the research tool and the extent to which it influences random error (Mohajan 2017).

To ensure the validity and the reliability of this research, the researcher followed the reliability and validity test conducted by Asikcan et al. (2017) presented in Table 3.12.

Table 3. 12: Validity and reliability test

No	Test	Relevant phase of the research
1	Construct validity	Data collection – This includes conducting the pilot test for the Study Two) questionnaire, with nine (9) academia representing about 5% of the target population and apply the outcome to enhance the quality of the questionnaire before eventually deploying it to professionals.
2	Internal validity	Data analysis – Conducted consistency test according to Pallant (2016) guidelines using SPSS Cronbach's alpha test (Table 4.7) to ensure the responses from the questionnaires were satisfactory.
3	External validity	Research design – Adopting a well-organised and appropriate research methods.
4	Reliability	All phases of the study – Adopting appropriate analytical tool for each phase of the study.

Source: Asikcan et al. (2017)

3.10 Overview of Ethical Issue

Ethics can be considered as those rules differentiating between "right and wrong – acceptable or unacceptable", "A code of professional conduct" or "a religious creed" (David and Resnik 2015). It is essential to note that there could be similar procedures among countries, however, each nation has its own consideration of ethical research (Chiumento et al. 2020).

Wellcometrust (2014) considered research ethics as moral values that direct how research work should be carried out by researchers. These values are applied to influence research regulations approved by groups such as communities, governing bodies, governments, or universities. In this case, research students in Robert Gordon University are required to comply with high ethical standards when conducting research. In making ethical decisions in research, it is imperative for a researcher to acquire knowledge for interpretation, assessment, and application of various research rules (ethics) in various situations (Kabir 2016).

For instance, a Consent Form (Appendices 7 and 12) which includes details such as the purpose of the research, the expectations from both the participant and the researcher etc. was developed by the researcher and approved by the Research Ethics Committee before proceeding with data collection. This form must be accepted and signed by the participant before the data can be collected. The Consent Form in appendices 7 and 12 relate to the semi-structured interviews, and the demonstration and validation of the decision-making model respectively.

Fundamentals of ethical consideration for this research as identified by Chetty (2016) and Saunders et al. (2019) are:

- Research planning – The research will ensure the dignity and the welfare of the research participants, avoid deceptive outcomes, and meet suitability.
- Protection of obtained Information – The researcher will obtain information from literatures associated with the study and these will be acknowledged.

- Evading Plagiarism- The researcher plan must follow procedures laid down by the school by ensuring that all materials in the thesis from other sources are suitably cited and referenced.

Kabir (2016) further presented ethical principles adopted by various agencies which include, objectivity, honesty, openness, carefulness, integrity etc.

The overall structure developed for this study can be presented in Figure 3.16 as shown:

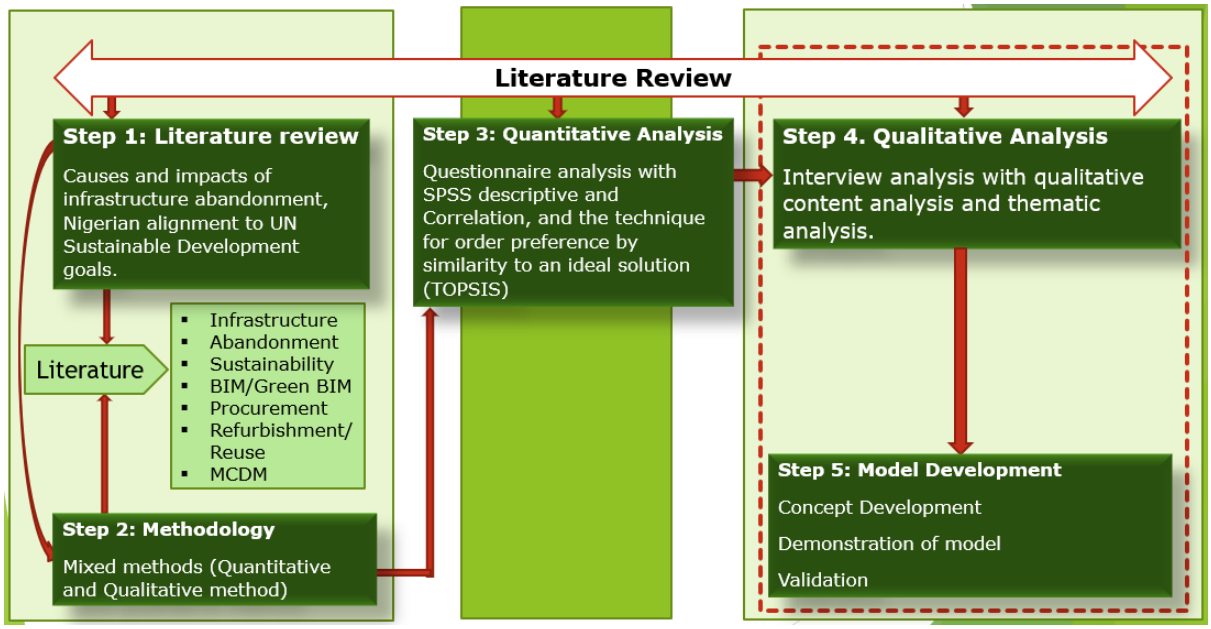


Figure 3. 16 : Overall structure of the research.

Source: Author generated

3.11 Chapter Summary

This chapter connected the different methodologies applied by this research including the justification behind their choices.

The effectiveness of the diverse methodologies was assessed in this chapter while presenting the argument that pragmatic paradigm with sequential mixed methods to collection of data was imperative for a comprehensive data collection.

The mixed method of data collection of both quantitative and qualitative were applied for the segmented studies (Study One, Two and Three). The methods and the analytical tools adopted for these three studies were also discussed.

Finally, this chapter presented the rationale for adopting the MCDM TOPSIS Model as the most suitable mathematical technique of selecting the optimum ideal solution from the possible solutions in addressing abandonment of Infrastructure in Nigeria. The justification for the model development supported with relevant resources were also presented.

The succeeding chapter examines the data collection and analysis techniques with reference to the methodologies adopted within this chapter.

CHAPTER FOUR: DATA COLLECTION AND ANALYSIS

4.0 INTRODUCTION.

Following the evaluation of the research methodology in the previous chapter, this chapter presents the data collection details. With the mixed method approach adopted in the overall research, this chapter describes the sequential details of the questionnaire surveys conducted prior to the interviews. The data analysis from both methods' inquiry entails SPSS Pearson correlation and TOPSIS for the quantitative analysis (Study One and Study Two – Figure 3.6), and qualitative content analysis and thematic analysis for the qualitative (Study Three - Figure 3.6) study are presented in this chapter accordingly.

The philosophical paradigm was also considered in the data collection and the analytical process as illustrated in the process chart (Figure 4.1).

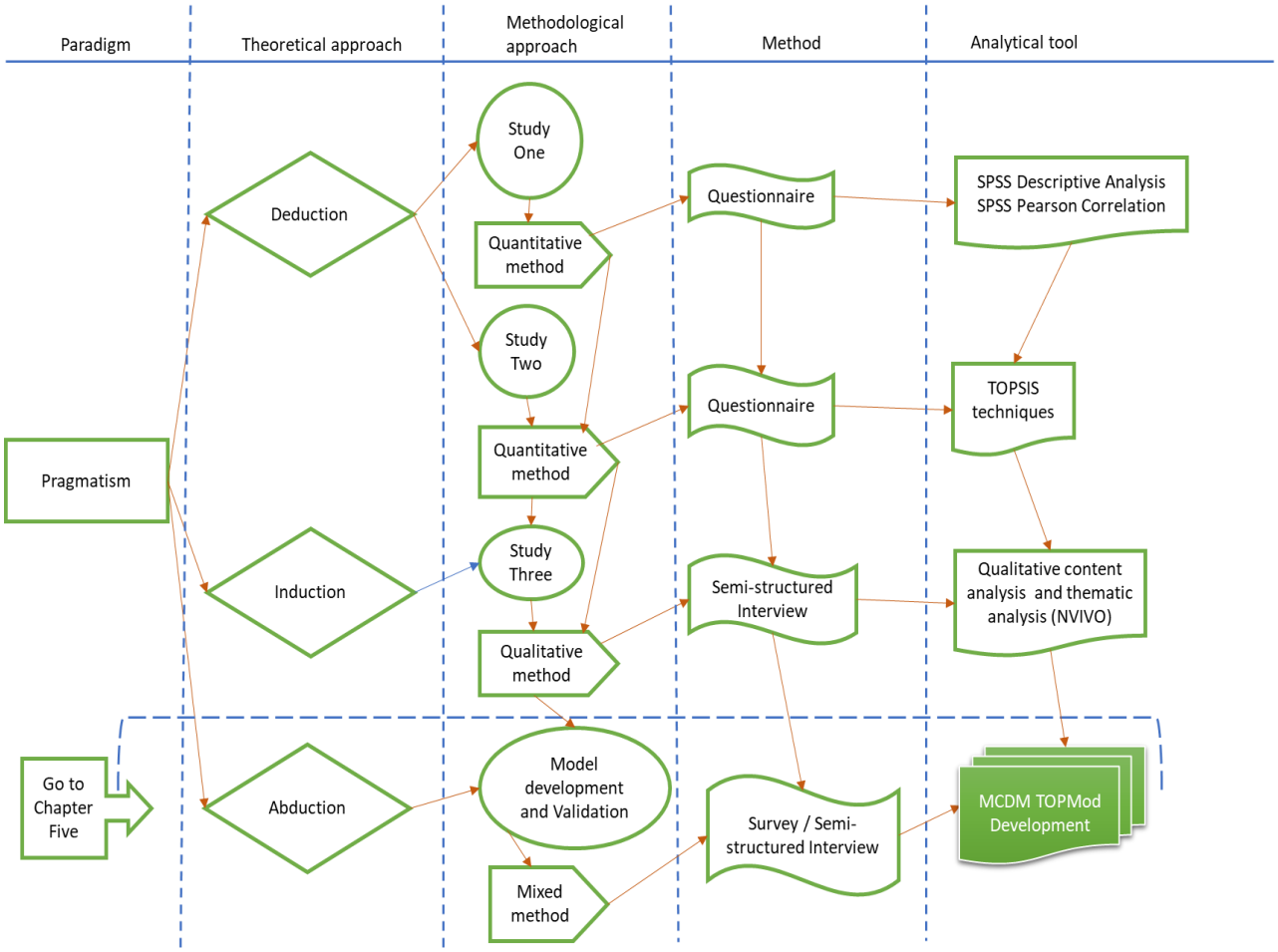


Figure 4. 1 :The process chart for the entire methodology.

4.1 Study One – Analysis of findings with challenges encountered during the study.

The first questionnaire deployed examined the procurement method adopted for infrastructure projects in Nigeria, determined the causes of abandoned infrastructure, evaluated the impact of factors contributing to the causes, and identified possible remedies for such structures. To obtain

information to aid the research analysis, multiple choice, open and closed - ended questionnaire, as discussed in Chapter 3 (distributed through a survey method), was collected from professionals in the built environment, with their demographic information indicated.

Meanwhile, data collection commenced on 26th March 2020. The global online platform was flooded with activities (due to pandemic) and a new working strategy was adopted in the construction industry as studied by Ogunnusi et al. (2020). The global connectivity and bandwidth interference were a serious challenge at that time due to remote working which would have affected the deployment of a semi-structured interview. Hence, the researcher's decision to allow the participants access the questionnaire and complete at their own timing.

The link to the questionnaire developed for use with Google Form was forwarded to professionals in the built environment through social media (Facebook messenger, email, LinkedIn). To overcome the sampling problem in research, such as a low response rate or biases (Brinck et al. 2010), Dawson (2011) stated that selecting a small manageable number is a better option. Although Dawson (2011) was not specific about what constitutes a "small" number, Amade et al. (2015) and Damoah et al. (2020) selected 115 participants and 146 participants respectively. Bullen (2022) was able to provide an insight to the "small sample" by confirming that the minimum sample to obtain any meaningful result is 100 while the maximum is 1000 (although the figure depends upon the size of the population and the level of certainty the research requires).

In this case, the research area was related to the built environment and random sampling was adopted when targeting professionals familiar with the construction research topics to provide adequate and necessary information for efficient analysis and findings. Participants were expected to complete the question and submit via the same medium, Google Form. The duration of the questionnaire data collection was two months lasting between 26th March 2020 and 2nd of May 2020.

4.1.1 Demographic analyses of the participants

From 138 responses received, 135 responses were considered valid, with three participants' responses deemed not reliable through non-completion of the questionnaire due to either inability to complete the demographic questions or some of the questions were not addressed appropriately (refer to Section 3.8). The built environment professionals, which included Architects, Builders, Engineers, Surveyors, Construction Procurement Personnel, Developers and Project Managers participated from five out of the six geopolitical zones Nigeria (North-East not represented) and covered both public and private sectors.

The different professionals are of varying years of experiences (Table 4.1) spanning from less than 1year to over 15years working experience. 59% out of the participants are in the high end of the experience range (15 plus +years). Their input reflected their wealth of knowledge and experiences in the building industry. There were 30% of professionals whose experiences cut across the public and private sectors. Moreover, there was homogeneity in the sampling, a larger percentage of participants were from the South-West region of Nigeria (Ogunnusi et al. 2021). This could also result from the prominence of knowledge, the level of education, and the extent of development activities in that region (Ogunnusi et al. 2021).

Table 4. 1 : Demography of the participants

Description	Category	No.	%
1) Profession	Architects	59	43
	Engineer	19	14
	Builder	4	3
	Surveyor	11	8
	Construction Procurement Personnel	2	2
	Project Manager	27	20
	Others	13	10
2)Years of experience in the industry	Not experienced (>1)	1	1
	Somewhat experienced (1-5 years of experience)	16	12
	Experienced (5-10 years of experience)	39	29
	Very experienced (more than 15years)	79	59
3)Category of Industry	Public Sector	16	12
	Private Sector	78	58
	Both (Public and Private)	41	30
4)Which part of Nigeria are you located (Geo-political zones)	North-West	1	1
	North-East	0	0
	North-Central	12	9
	South-West	102	77
	South-East	5	4
	South-South	13	10

Figure 4.2 presents the results of participants' involvement in construction projects that failed and were subsequently abandoned. It was obvious that the number of participants who experienced abandonment are fewer than those with no experience. This allows the participants to reflect on their experiences based on the subject (Graham et al. 2007, Nyumba et al. 2018). Even so, the results significantly show that abandoned cases are real, and that there is an actual cluster of responses on abandonment from the South-West region. This relocation of the government seats from Lagos to Federal Capital Territory Abuja could also contribute to this finding as discussed in Table 2.3 in Chapter 2.

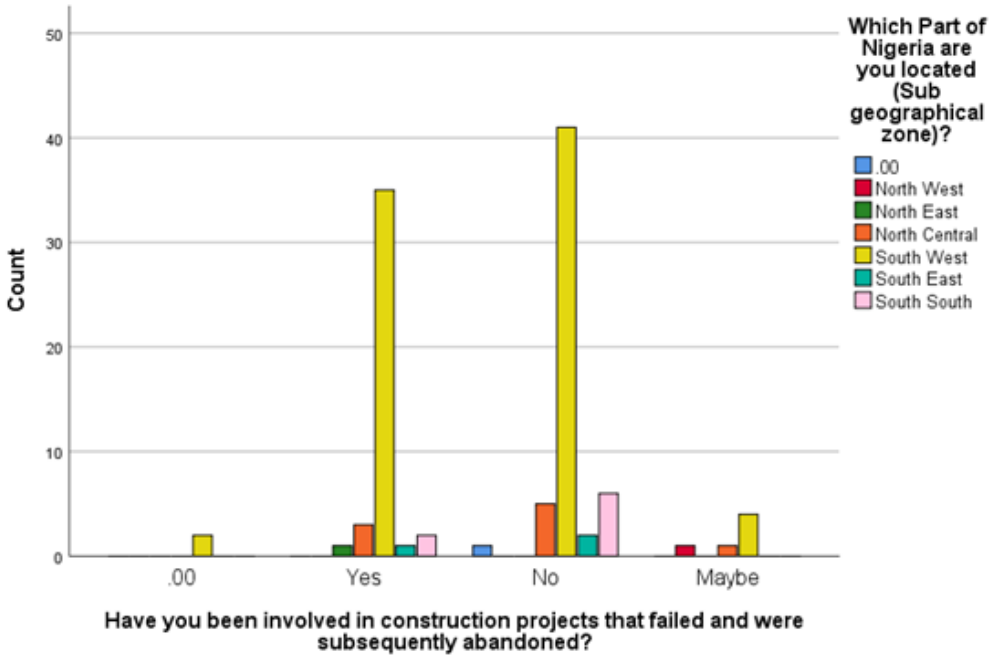


Figure 4. 2 :Involvement in abandoned projects in the sub-geopolitical zones.

Source: Author generated

4.1.2 Sample's involvement in abandoned projects

Abandoned buildings are experienced by participants in both private and public sectors (Section 2.1.3). 44% of the total respondents confirmed their involvement with abandoned buildings, as highlighted in Figure 4.3. Further analysis of those participants that were involved in the abandonment include 23% from public sector, 10% from the private while 17% operates in both sectors. Although none of the literature reviewed presented this form of questions. However, it is required in this context to obtain participants understanding and to also ensure the relevance of this question in connection to other questions in the questionnaire.

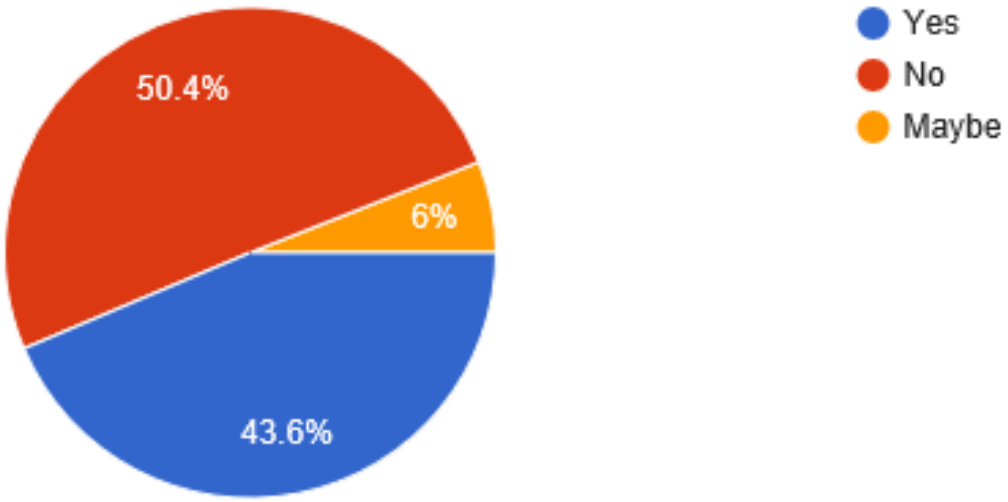


Figure 4. 3 : Participants involvement with abandoned building

Source: Author generated

Given the result of the question regarding participants' involvement in abandoned buildings, 57% of the total participants identified as being "very experienced" professionals with over 15years in the industry. 50% of these professionals confirmed having been involved with at least one abandoned project which confirms the agreement of Nnamseh et al. (2021) and Doraisamy et al. (2015) of abandonment as a global phenomenon. On the other hand, 43% have no experience with abandoned buildings and 7% of participants were not sure of their involvement in abandoned infrastructure.

Participants were requested to indicate the form of contract adopted for projects within their respective organisation. Some of the participants indicated the use of a standard form (such as FIDIC, JCT and NEC) of contract for their respective projects, some of which failed and then were abandoned. Of the 44% of those involved in abandonment, 54% utilise JCT, while 16% and 15% employed FIDIC and NEC respectively. The remaining 15% mentioned different bespoke contract forms adopted by an individual organisation. According to Tijan and Ajagbe (2016), failure to align with practical completion date or improper documentation of contract agreement/conditions are some of the critical factors to abandonment. Poor funding and faulty procurement process were commonly given as a reason for abandonment, as highlighted in Table 4.2.

With the use of the frequency descriptive analysis tool in SPSS, the responses on the nature of the impact of abandoned infrastructure in Nigeria (Table 4.2) include being non-eco-friendly (NE), uneconomical (UE), constitutes social menace (CSM), waste of useful resources (WUR) and "All of the above" (ATA). ATA ranked highest which signifies that approximately 80% of respondents agreed that abandonment in Nigeria is NE, UE, CSM and WUR and significant as mentioned by (Amade et al. 2015).

Table 4. 2 : Participants and their responses to some questions.

	Description	Freq.	%
7)Which Form of Contract Do you use mostly in your organisation?	JCT	70	51
	FIDIC	13	10
	NEC	13	10
	Others	62	45
8)If you have been involved in abandoned projects, could you please state the cause(s) for such building or projects failure?	Funding from the federal government	42	31
	Planning	23	17
	Change in government	11	8
	Corruption	10	7
	Procurement	7	5
	Politics	4	3
	Management	3	2
9)Have you been involved in construction projects that failed and were subsequently abandoned	Yes	58	42.6
	No	67	49.3
	Maybe	8	5.9
	No response		
10) In your opinion, what do you think is the impact of abandoned Infrastructure in Nigeria? (tick as many)	Non-eco-friendly (NE)	2	1.5
	Uneconomical (UE)	3	2.2
	Constitute Social Menace (CSM)	6	4.4
	Waste of useful resources (WUR)	25	18.5
	All of the above (ATA)	97	71.9

11)As a professional, what do you think is the remedy for abandoned projects in Nigeria (tick as many)	Designing with deconstructability in mind (DDM)	45	33.3
	Refurbishment of abandoned projects (RAP)	65	48.1
	Using an innovative management tool (UIMT)	82	60.7
	Changing procurement methods (CPM)	71	52.6

4.1.3 Possible remedies for abandoned projects

For the questions addressing possible remedies to abandoned projects, as stated in Table 4.2, the need for innovative management tools ranked as the highest rated remedy at 82%. Bossink and Vrijhoef (2015) addressed innovative management tools to initiate opportunities for managers of organisations to enhance innovativeness for their structures and processes. In this regards, Khaddaj and Srour (2016); Okakpu et al. (2018); Daniotti et al. (2021) studies identified the need for adaptation of a framework to standardise the BIM adoption and implementation in existing buildings for refurbishment. The four elements considered as remedies in Table 4.2 were discussed in section 2.3 (procurement), 2.6.1.5 (deconstructability), and 2.5 (refurbishment; innovative tools) respectively.

10% of participants mentioned BIM as a tool that can be used to drive sustainable procurement of infrastructure in Nigeria. According to Edwards et al. (2019), BIM was completely utilised to enable Green building practices. Changing to sustainable procurement methods is also a consideration in seeking a solution to abandoned infrastructure as highlighted by Oyewobi et al. (2017). Refurbishment of abandoned infrastructure can be seen in the view of the following authors as:

- adaptively reusing and refurbishing abandoned, or underutilised buildings can invigorate the societies while accomplishing environmental values (Foster 2020).
- New building is costly, nevertheless, some of the abandoned building on the other hand hold historical significance. They are better repurposed for public use (HMC Architects 2020).
- Innovative and resourceful approaches for existing buildings and built environment are imperative in realising sustainability in the future. In urban development, it is imperative to find sustainable solutions for these buildings (Foster 2020).

'Designing with deconstructability in mind' (Table 4.2) has the lowest ranking. Since this concept is arguably new in construction with earlier forms within the concept of constructability and buildability, there is less anticipation of its usage on structures abandoned within the period 2003 – 2023.

4.1.4 Tool utilisation in projects

There are varieties of technological tools expected to drive sustainable procurement of infrastructure in Nigeria as mentioned by the respondents. The tools mentioned include Primavera v6, Microsoft project (MS), BIM, gBIM, EGDE, Graphical method, JIRA, E- Procurement systems, Excel, I-sourcing tool and e-sourcing tool, STARS, SAP, LEED, ERP, Smart Contract, Lean construction, Proactive, Procurify, Negotiates, Precoro, Archicad eco designer and SBAT.

From Figure 4.4, 44% agreed to have deployed either one or more of the tools on their infrastructure projects while another 41% of the participants indicated that they have not used the tools in any of their infrastructure projects.

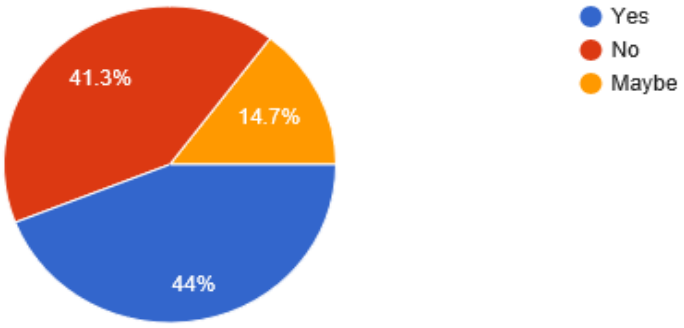


Figure 4. 4 : Utilization of technological tool for sustainable procurement

Source: Author generated.

4.1.5 Correlation of variables employing Pearson Correlation in SPSS.

In identifying the statistical relationship among the variables of designing with deconstructability in mind (DDM), refurbishment of abandonment projects (RAP), using an innovative management tool (UIMT) and changing procurement methods (CPM) (Table 4.3), Pearson's correlation in SPSS was adopted. With the multivariate correlation between the four variables, DDM, UIMT, RAP, CPM from the data collected from the samples size (n=135) and two – tailed significance test, Table 4.3 indicates the correlation coefficient for every combination of the four variables:

Correlations of identified key variables.

Table 4. 3 : SPSS Pearson Correlation of identified key variables.

		DDM	UIMT	RAP	CPM
DDM	Pearson Correlation	1	.182*	.294**	.073
	Sig. (2-tailed)		**.034**	**.001**	**.397**
	N	135	135	135	135
UIMT	Pearson Correlation	.182*	1	.076	.027
	Sig. (2-tailed)	**.034**		**.378**	.760
	N	135	135	135	135
RAP	Pearson Correlation	.294**	.076	1	-.005
	Sig. (2-tailed)	**.001**	**.378**		.950
	N	135	135	135	135
CPM	Pearson Correlation	.073	.027	-.005	1
	Sig. (2-tailed)	**.397**	.760	.950	
	N	135	135	135	135

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation between the variables DDM/UIMT and DDM/RAP (Table 4.3) at 0.182 and 0.294 respectively indicates a weak relationship between them. The assessment of the correlation between the variables identified as weak relationships was adopted from Nettleton (2014); Sanli (2019) and BMJ (2023). The P-Value of the correlations of these variables are 0.034 and 0.001, which leads to a positive correlation at (+1) as applied by Williams et al. (2020). This indicates that there is a statistically

significant relationship between DDM & UIMT at 0.01 level (2-tailed) and DDM and RAP at 0.05 level (2-tailed) (Kent State University 2021; Szafran 2022). This further supports the need for adoption of innovative management technology for refurbishment, as posited by Ogunnusi et al. (2021).

Therefore, innovative management tool is further reconsidered as elements for the sustainability attributes of technological and alternatives for refurbishment. With sustainability in mind, and further literature review identifying the configuration of criteria and attributes, the UIMT was represented as other criteria such as "*project preparation and coordination*" and "*structural integration and foundation*" to enhance the development of the model as a tool.

4.2 Study Two – TOPSIS Analysis of the Questionnaire

To ensure sustainability focus within this research, the second questionnaire complemented the first questionnaire by designing the instrument to include questions (centered on alternatives and criteria (Figure 4.5) as mentioned in Chapter 3. that relate to redevelopment of abandoned structures from the sustainable viewpoint. With this in mind, the subsequent section illustrates the analysis of the data collected from the second questionnaire commencing with pilot study (Table 4.4).

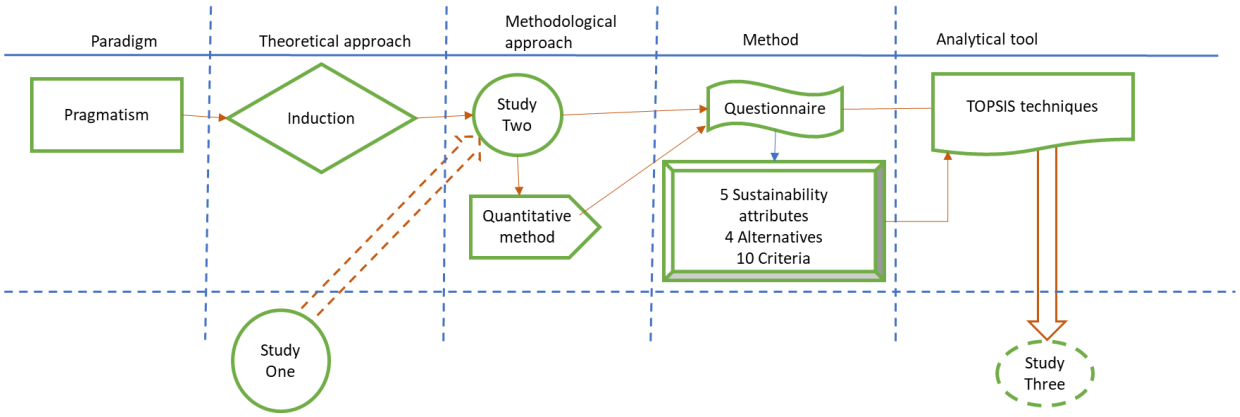


Figure 4. 5: Flow chart for Study Two Analysis

4.2.1 Piloting of the research instrument

Six (6) research students (PhD candidates) and three (3) academics were contacted to pilot the research instrument. The questionnaire with fifteen (15) closed - ended and five (5) open-ended questions was distributed among colleagues both within and outside the University (RGU) for critique.

Six PhD Candidates completed and forwarded their comments on areas of improvement of the questionnaire while two out of three academics (ACA1, ACA2, ACA3) outside Robert Gordon University (both from a UK and a Nigerian university) forwarded their input – ACA1 written, ACA2 verbally and ACA3 used both mediums. The researcher also sought clarification for some unclear responses (Table 4.4) from some of the participants.

Table 4. 4 : Clarification of some of the unclear responses from the pilot participants

Participants	Comments /Clarification	Changes effected
PhD Candidate	Scrap 15-20 and consider converting them to interview questions.	Four questions were removed instead of Five. The fifth open-ended question was retained purposely to create a platform for the next data collection.
ACA 3	I feel you need to look at questions 6 and 7. Q6 - Awareness can only be Yes or No. If yes, then, give option of well – informed, participated etc. If no, they can go to other questions.	The five options were retained. However, the question was rephrased for better understanding of the intended participants
	You had four options earlier, Refurbishment, Conversion, Demolition and Selling. Why three details?	The omitted ten (10) sub-questionnaire as Selling (Figure 4.6) alternative was included
PhD Candidate 3	I suggest you remain focused and fine-tune the actual questions with your supervisors after getting feedback from other colleagues, since some may not necessarily have to be taken on board	This was considered.

Based on the clarification of the questions by the pilot participants, the questionnaire was amended down to sixteen (16) questions from twenty (20). The reason was each of the four (4) MCDM questions were in multiples of ten (10) sub-questions (Figure 4.6). The respondents may not complete the survey on time and as expected if faced with many questions (56 No) (Brosnan et al. 2021). Responses to too many questions from a questionnaire, especially the technical ones, may be delayed. To obtain reasonable (in terms of both the total number and the time taken) responses, the advice was to review the number of questions for ease of completion. For instance, in addressing the issues with regards to number of questions in a questionnaire, Caltenco et al. (2012) configured the questionnaire (of minimum of 26 and maximum of 63 questions) into sections that are of interest to the participants. Consequently, all these were considered in developing the final questionnaire.

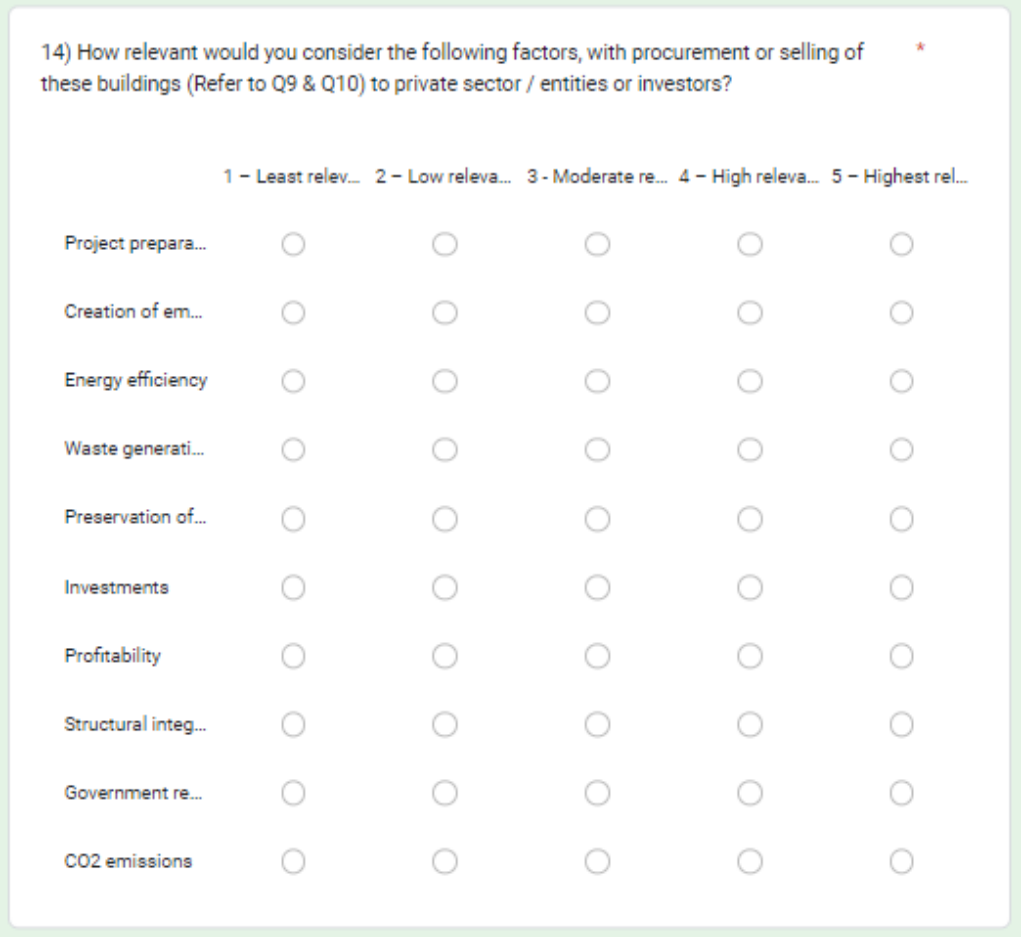


Figure 4. 6 :Sample of Alternative / criteria question in the Questionnaire.

Source: Author generated.

An open - ended question was also provided in the questionnaire to clarify the possible need for qualitative study of this research. The targeted sample size (based on the level of awareness of sustainability) using random sampling was 120 participants. These participants comprised of some of the initial first quantitative study respondents that signified interest in the main study. However, 167 professionals participated in the survey. The additional 18% (to the target participants) were mostly non-built environment professionals. Since the research focuses on sustainability, other allied professionals (mentioned in Section 4.2.2) knowledgeable in building sustainability, but not necessarily built environment professionals, were also encouraged to participate in the survey (Ogunnusi et al. 2023). The data obtained from the two sets of professionals (Built environment and allied industry) were analysed together, which is considered beneficial in the context of this research. The sample was homogenous with 82% of the professionals in built environment. The reason for the inclusion of the allied industry professionals was to obtain robust responses in addition to those in the built environment since the abandonment issues relates to sustainability issues as well. More so, the integration of the two groups was adopted from Carr's (2018) interdisciplinary research.

4.2.2 Demographic analyses of respondents

171 responses were initially received with 167 of them validated. Two responses came without demographic information while another two were repeated submissions from an individual.

The respondent by profession includes engineers, project managers and quantity surveyors. The other allied professionals, an environmental scientist, financial analysts, soil scientist, bankers, urban planners, real estate managers, public analysts, environmental technologists, academics, lawyer, amongst others. Additional information on the participants, including their level of experience is detailed in Table 4.5.

Table 4. 5 : The demography of the respodents

Description	Category	Number	%
Profession	Architects	34	21.11
	Building Engineers	6	3.72
	Civil Engineers	21	13.04
	Electrical Engineers	5	3.13
	Construction/Project Managers	25	15.63
	Quantity Surveyors	32	19.87
	Property Developers	4	2.48
	Contractors	4	2.48
	Others	30	18.63
Years of experience	Somewhat experienced (<5)	24	14.90
	Experienced (5-10years)	49	30.43
	Very experienced (11-15)	32	19.87
	Highly experienced (more than 15 years)	56	34.78
Academic qualification	College / Ordinary National Diploma (OND)	1	0.62
	Higher National Diploma (HND)	12	7.45
	First Degree	48	29.81
	MSc	94	58.38
	PhD	6	3.72
Sector of operation	Public Sector	10	6.21
	Private Sector	97	60.24
	Both (Public and Private)	54	33.54

Source: Author generated

4.2.3 What is the level of awareness of abandoned projects in Nigeria.

The essence of this question is to gauge the understanding of the participants and to know the level of awareness of the 18% new participants (Table 4.5, Figure 4.7). This question required the participants to choose from multiple options and 6% of participants were identified to have participated in abandoned projects. Although this is lower than expected (based on the data in the previous study), the style of questioning also provided robust identification of participants' level of involvement with abandon projects that when a Yes or No answer is provided (see Section 4.1.2).

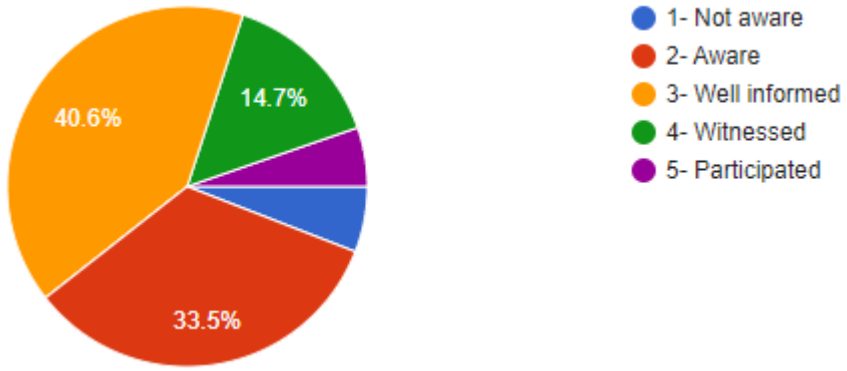


Figure 4. 7 :Level of awareness of abandoned projects in Nigeria.

Source: Author generated

4.2.4 The participant's awareness of sustainability issues

In addressing abandonment and sustainability issues, it is necessary to ascertain the level of awareness (Table 4.6) of the participants that informed their decisions of the best option selected. 60% of the participants claim good awareness of these five options. From further evaluation, 24% out of the 35% highly experienced participants are highly aware of environmental sustainability. These can be an added advantage to awareness of the impact of the subject of discussion.

Table 4. 6 : Awareness level of sustainability

Sustainability	1-No or low awareness	2- Basic awareness	3- Average awareness	4 - Good awareness	5 - High awareness
Environmental	6	22	37	60	35
Economic	5	25	31	64	35
Social	6	22	33	68	29
Technological	10	20	34	60	35
Political	11	27	41	52	28

The multiple-choice questions (Figure 4.6) of the Google Form, used as the instrument for the questionnaire, enhanced the integration of the four alternatives as the four major MCDM questions. Each of the four questions were juxtaposed with 10 options / criteria based on the level of relevance.

Q11- How relevant would you consider the following criteria while **refurbishing** the original buildings for their historical purposes?

Q12 - How relevant would you consider the following criteria while **converting** the buildings into apartment housing and preserving the architectural-urban expression?

Q13- How relevant would you consider the following criteria for the **demolition** of the building and the implementation of a new design?

Q14- How relevant would you consider the following criteria with partial or outright sale to private sector/ entities or investors?

The questions were carefully collated employing the 5-point Likert scale format (Least relevance -1, Low relevance - 2, moderate relevance - 3, High relevance -4 and Highest relevance -5) to appraise the perception of the participants regarding the relevance of the ten (10) criteria associated with each of the four (4) alternatives (Please refer to Chapter 3, Figure 3.12, level 3 & 4). The interpretation of a 1 to 5 scale can be based on relevance as adopted from Omotayo et al. (2020) and Balioti et al. (2018). Within SPSS, Cronbach's alpha was used to measure consistency of the data collected with the minimum acceptable criterion of 0.7 Cronbach alpha (α=alpha) for measuring the reliability (Table 4.7) of the data (Pallant 2016). The Cronbach alpha result obtained for the data was α=0.823 which confirms the reliability of the data.

Table 4. 7 : Consistency and Reliability test

Case Processing Summary

		N	%
Cases	Valid	167	100.0
	Excluded[a]	0	.0
	Total	167	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.823	.830	10

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.823	.830	10

4.2.5 The average Value and ranking of the criteria.

With the use of Microsoft Excel, Table 4.8 presents the average mean value (AMV = Sum/number) of the 167 participants (Azad 2023; Sial 2023). The AMV was developed as an average mean of each

criterion when evaluated against each alternative (Refer to Chapter 3, Level 3 & 4 of Figure 3.12 in Section 3.8.2.5).

The average mean value provided by the participants for the ten (10) criteria (C1-C10) with respect to the four (4) alternatives (Q11-Q14) are summarized in Table 4.8 -Decision matrix. The decision matrix was utilised for the TOPSIS analysis. The table format was adopted from Vassoney et al., (2020) highlighting the MCDM problem in the form of a matrix where the columns and the rows indicate the criteria and the alternatives respectively.

Table 4. 8 : Decision Matrix (AMV with ranking)

N	Criteria	Q11	R	Q12	R	Q13	R	Q14	R
C1	Project preparation and coordination	**4.15**	3	**4.11**	3	**3.74**	3	3.78	
C2	Creation of employment opportunities	**4.16**	2	4.08		3.53		3.83	
C3	Energy efficiency	3.99		3.99		3.54		3.61	
C4	Waste generation / prevention	3.84		3.84		**3.92**	1	3.46	
C5	Preservation of historical value	3.49		3.30		3.63		3.23	
C6	Investments	4.10		**4.13**	2	3.62		**4.12**	2
C7	Profitability	4.01		4.07		3.45		**4.18**	1
C8	Structural integrity and foundation	**4.47**	1	**4.39**	1	**3.84**	2	**3.98**	3
C9	Government regulations and policies	3.61		3.62		3.43		3.5	
C10	CO_2 emissions	3.65		3.75		3.56		3.33	

*R - Ranking

From Table 4.8, "***Structural Integrity and foundation***" (C8) one of the two criteria under *Technological* attributes (Figure 3.12), emerged top on the list for the *refurbishment* and *conversion* alternatives. This is necessary to ensure the stability of the structural elements of the structure before any of the two alternatives (Refurbishment – Q11 and Conversion – Q12) can be considered.

4.2.6 TOPSIS Analysis

This is the analysis of the four alternatives in Level 4 of Figure 3.12 with the application of TOPSIS**.** The MS Excel used for the analysis was adopted from Fattoruso (2022); Cerneviciene and Kabasinskas (2022); Pramanik et al. (2021) as tables and simple displays are often required to present reasoning and thoughts.

The values of the four alternatives were obtained from the decision matrix in Table 4.8.

4.2.6.1 Normalisation

According to Vafaei et al. (2018), normalisation is an indivisible part of the decision - making procedure and it is required to achieve dimensionless units such as common numeric scale / range for determining the final rating per alternative. Data normalisation is requisite for decision-making methods since data needs to be comparable and numerical to be collected, measured, and ranked into a definite score per alternative (Etzkorn 2015; Vafaei et al. 2016).

Normalisation works towards attaining equivalent scales which permit the comparison of alternatives. The vector normalisation method divides the rating of every alternative to compute the (x_y) the normalised value. Mhlanga and Lall (2022) viewed normalisation as an important step in TOPSIS as it can impact the ranking list. The ranking can change when diverse normalisation tools are adopted.

With the terminologies previously discussed, the adapted TOPSIS method from Mathew (2018a) is described as follows:

Step -1 Calculate Normalised Matrix.

This step transforms the different alternative sections into non-sectional alternatives, which permits appraisal across criteria. The normalised matrix of Table 4.8 is calculated using the formula in step 1 to achieve Table 4.9.

$$\overline{X_{ij}} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{n} X_{ij}^2}}$$

Table 4. 9 : Normalise matrix and weightage.

Whtg	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
Alt.	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
(Q11)	0.526	0.533	0.526	0.510	0.512	0.512	0.510	0.535	0.510	0.510
(Q12)	0.520	0.522	0.527	0.509	0.483	0.517	0.517	0.525	0.511	0.525
(Q13)	0.474	0.452	0.467	0.520	0.531	0.452	0.438	0.460	0.484	0.498
(Q14)	0.478	0.490	0.476	0.459	0.473	0.516	0.530	0.476	0.495	0.466

Step - 2 Calculate weighted Normalised Matrix

Compute the weighted normalised matrix by assuming a set of weights for each of the criteria w_j = 1/n. The mean weight (MW) can be adopted in the absence of information or when the information is not sufficient or available to attain a decision (Odu 2019; Mathew 2018b).

$V_{ij} = \overline{X_{ij}} \times W_j$ W_j= 1/n i.e 1/10 that is 0.1 (Table 4.9)

where n is the number of criteria

Multiply the associate weight with each column of the normalised matrix. A component of the new matrix will emerged as the content in Table 4.10:

Table 4. 10 : Weighted normalised matrix and ideal values

Alt	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**
(Q11)	0.0526	0.0533	0.0526	0.0510	0.0512	0.0512	0.0510	0.0535	0.0510	0.0510
(Q12)	0.0520	0.0522	0.0527	0.0509	0.0483	0.0517	0.0517	0.0525	0.0511	0.0525
(Q13)	0.0474	0.0452	0.0467	0.0520	0.0531	0.0452	0.0438	0.0460	0.0484	0.0498
(Q14)	0.0478	0.0490	0.0476	0.0459	0.0473	0.0516	0.0530	0.0476	0.0495	0.0466
v+	0.0523	0.0532	0.0527	0.0520	0.0531	0.0517	0.0530	0.0535	0.0511	0.0525
v-	0.0473	0.0452	0.0467	0.0459	0.0473	0.0452	0.0438	0.0460	0.0484	0.0466

Step -3 Calculate the ideal best and ideal worst value

This is achieved by evaluating the maximum value (V+) and the minimum value (V-) (Table 4.10).

Positive ideal best value, {V+ = V_i ,…….,V_n } = { max (v_{ij}) if j ϵ J; min (v_{ij}) if j ϵ J'}

Negative ideal worst value, V- = { v_i ,……..,v_n }, where v'= { min (v_{ij}) if j ϵ J; max (v_{ij}) if j ϵ J'}

J is reffered to as a set of benefit attributes (larger – the - better category) and J' is reffered to as a set cost attributes (smaller – the- better category)

Step - 4 Calculate Euclidean distance from the ideal best (S_i^+) (Table 4.11). Compute the measures for each of the alternatives. The seperation of each of the alternative from the positive ideal alternative is stated below:

$$S_i^+ = \left[\sum_{j=1}^{m} \left(V_{ij} - V_j^+\right)^2\right]^{0.5}$$

Step – 5 Calculate Euclidean distance from the ideal worst (S_i^-) (Table 4.11). The seperation of each of the alternative from the negative ideal alternative is stated in the formula as follows:

$$S_{\bar{i}} = \left[\sum_{j=1}^{m} \left(V_{ij} - V_{\bar{j}} \right)^2 \right]^{0.5}$$

Step - 6 Calculate Performance Score (P_i) (Table 4.11). The Performance score as stated in the formula is the division of the Euclidean distance from the ideal worst by the addition of both the Euclidean distance from the ideal best and the Euclidean distance from the ideal worst.

$$P_i = \frac{S_{\bar{i}}}{S_i^+ + S_{\bar{i}}}$$

Table 4. 11 : Performance score and ranking

Alternatives	**S_i^+ (C1-10)**	**S_i^- (C1-C10)**	**P_i (C1-C10)**	**Rank**
Refurbishment(Q11)	0.003394	0.018419	0.844391	1
Conversion (Q12)	0.005374	0.017935	0.769457	2
Demolition (Q13)	0.018088	0.009037	0.333158	4
Selling (Q14)	0.014492	0.012058	0.454151	3

In summary, the six - step process ranked the alternatives according to Table 4.11 as Refurbishment > Conversion > Selling > Demolition. With respect to the final scores, it can be determined that refurbishment is considered as the most sustainable development alternative for the abandoned Federal Secretariat building in Nigeria.

From the TOPSIS method consideration of four alternatives and ten criteria as listed in Figure 3.12, it is obvious that *Refurbishment and adaptation to current needs while maintaining or slightly changing the original building and its historically established purpose* (**Q11- Refurbishment)** is considered the most suitable and sustainable option for the redevelopment of the abandoned Federal Government Secretariat.

4.2.7 Findings from the study two questionnaire

From the analysis of Study Two, refurbishment has been considered the most sustainable route, by the participants, for the rescue through refurbishment of the presented case study - the abandoned Nigerian Federal Secretariat building in Lagos. Structural Integrity and Foundation (Table 4.8), one of the Technological attributes ranked highest out of the five (5) attributes of social, economic, environmental, political and technological (SEEPT) attributes. This affirms the relationship between refurbishment and technological attributes (Ogunnusi et al. 2023).

4.2.7.1 Further Findings from the Questionnaire

The open-ended question (Q15) within the questionnaire (Chapter 3, Table 3.6) was "*What do you feel would be the best way (with sustainability in mind) to address the abandonment of infrastructure in Nigeria*? 146 participants responded to this question. Even though demolition ranked the lowest in the available answers for Q11 to Q14 (Table 3.6), 4% of the participants believed all abandoned structures should be categorised as either of good structural standing or bad structural standing. Responses such as "*Sell/ refurbish buildings with good structural integrity, demolish structural poor*

ones" and "……*"in the case of buildings who had failed structural integrity, the best thing is to pull it down!* signify that the weak structures should be considered for demolition while the strong structures should either be refurbished, converted, or sold. Structural stability and foundation ranked highest among the criteria in section 4.2.7, this finding requires the need for a semi-structured interview (Section 3.8.3) as Study Three to ascertain robust professional opinion on this discussion with sustainability in mind in developing a framework.

With purposive sampling as discussed in section 3.8.3.1, a range of 15-50 built environment professionals from the respondents in Study Two were identified for the semi-structured interview based on the validity of their responses, years of experience and level of awareness (Dworkin 2012).

4.3 Study Three – Content Analysis and Thematic Analysis of the Semi-structured Interview.

The qualitative content analysis and the thematic analysis were adopted within this section to comprehend the participants perceptions of waste management of abandoned infrastructure and also their thoughts about how best to address the abandonment with sustainability mind set. This section concentrates on analysing the data generated through the semi-structured interviews (Figure 4.8) conducted between February 3rd to February 24th 2022. The questions were intended to capture participants' experience(s) about abandonment in Nigeria. After the demographic information, the interview commenced with the participants affirming their individual response from Study Two on "the level of awareness of the participants based on abandoned structures in Nigeria". Five options were indicated in the quantitative questions in the questionnaire survey in Study Two. These options include the "*not aware, aware, well informed, witnessed and participated*" (Refer to Chapter 3, Q6 in Table 3.6 and Q2 in Table 3.11). Table 4.13 also highlighted the specific option selected by each participant and the interview discussion continued based on the option initially selected.

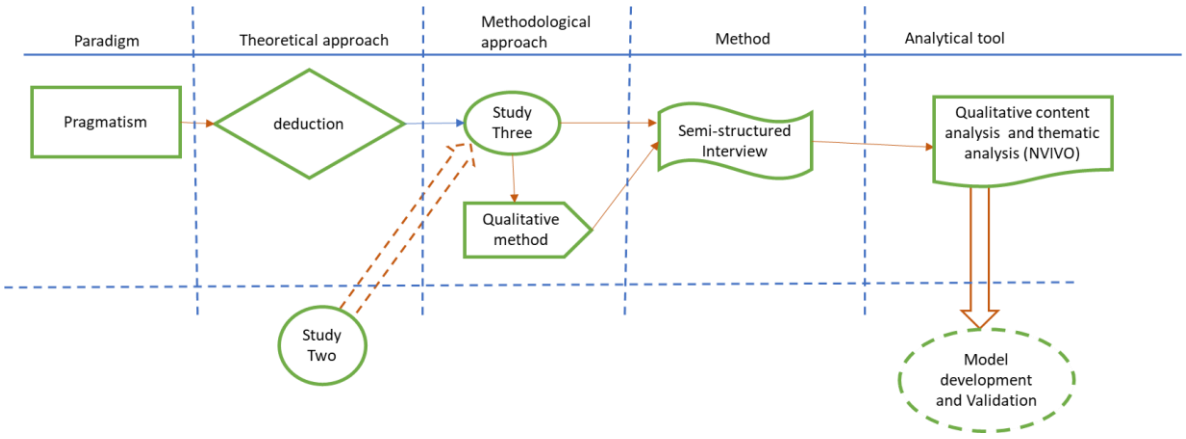


Figure 4. 8 : Flow chart for Study Three Analysis

The interviewer also investigated their "thoughts about sustainable development" and "the best way to address abandonment of infrastructure in Nigeria with sustainability in mind". Their responses to the other questions are highlighted in different sections of this chapter (Refer to Table 4.12).

Table 4. 12 : Interview questions in sections

N	Questions	Sections
1	Profession, Years of experience, Sector….	4.3.1
2	From your response to (Q6) within the online survey, you are "well- informed" about abandoned projects in Nigeria. Can you share your experience about these abandonments?	4.3.2
3	What are your thoughts about sustainable redevelopment?	4.3.3
4	Within the online survey, (Q15) You suggested that you felt "the best way (with sustainability in mind) to address the abandonment of infrastructure in Nigeria" was…….. Can you please explain your thinking behind this suggestion?	4.3.4
5	Were there any particular issues or criteria which you took into account? (e.g., finance, practicalities, impact)	4.3.5
6	Would the approach you suggest be used in other situations? E.g New Development.	4.3.6

4.3.1 The Participant's Profile

In this section, are questions associated with the respondent's profile. They were information already provided during the previous quantitative (questionnaire) data collection. Within the interview, the participants were given the opportunity to further express and introduce themselves including their profession, years of experience, sectors, qualification, and professional bodies (optional).

In total, 15 professionals participated. However, only 12 interviews were analysed due to the invalidity of 3 participants' interviews. The invalidity was as a result of bad network interference issues. For instance, one of the participants logged in from different devices, but still could not achieve a clear network. Another participant had to leave one location to another, but all to no avail. Scheduling another time for the interview was not feasible due to the busy schedule of these 3 participants. All these participants exclusively operate in the built environment as explained in Chapter 3.

Table 4. 13 : Demography

S/N	Profession	Acronym	Yrs of Exp.	Sector	State of awareness
1	Project Manager	PM 1	47	Both	Well Informed
2	Quantity Surveyor	QS 1	35	Private	Well Informed
3	Contractor	CON 1	34	Both	Aware
4	Civil Engineer	CE 1	30	Private	Participated
5	Architect		37	Both	Well informed
6	Architect	ARC 1	8	Private	Well informed
7	Construction Manager	CM 1	22	Both	Participated
8	Builder	BU 1	27	Both	Well Informed
9	Project Manager	PM 2	16	Both	Well informed
10	Architect	ARC 2	30	Both	Witnessed
11	Quantity Surveyor	QS 2	20	Private	Well informed
12	Architect		20	Both	Well informed

Another reason for selecting the participants is that over 70% of them should be *well informed* (as provided in the Study Two questionnaire) about the subject matter (abandonment). It is necessary to select interview participants with better chances of attaining more reliable information (Dawson et al.

1993). 67% of the participants were *well informed*, 16% *participated* while about 8% were *aware* or *witnessed* abandonment. The 1% highly experienced participants that indicated '*Not aware*' were not considered for selection. The "well -informed" are the participants that are not only aware of abandonment, but were also knowledgable in the subject matter.

The participants were able to share their experience and awareness of abandoned infrastructure. 8 (67%) of these 12 professionals functioned in both public and private sectors which enriched the level of their knowledge and exposure to the issue being studied. Ihugba et al. (2019) attests that 'total prohibition' (of functioning in both public and private sector at the same time) is not the best approach, rather it is better to proceed through the management of any conflict of interest.

For each interview, the interviewer appreciated each interviewee for accepting to participate in the interview despite their busy schedule, and reiterated the aim of the interview as stated in the consent form. 83% of the the participants were able to address the questions with minimal digression or examples, while some elaborated to present their contributions. The elaboration could be due to the information provided by the interviewer that there was flexibility for extension of the duration outside the stated time duration. The interviewees were also provided the opportunity to decline any question that was not clear to them as the question can be rephrased or removed.

All the participants reconfirmed their interest to participate in the recorded interview. The interviewees were requested to introduce themselves, and provide their demographic information; profession, years of experience and the sector represented (Please refer to Table 4.13).

4.3.2 Participants further Insight on abandonment

These experiences were shared from different perspectives; insight into abandonment by the government (public parastatals), abandonment of project implemented by organisations, and abandonment perceived by general observation peculiar in the construction industry with the anticipation of being called upon as a professional to help with redevelopment.

To commence the interviews, the interviewer set the scene by prompting the interviewee to share their experience about abandonment in Nigeria. All the participants relayed their experiences about abandonment in Nigeria with different themes emerging such as 'dotted' by PM1, CE1 and ARC 1
'……*dotted all over the city..'*

'……dots the nation…..'

'…..dotted all over the country'.

"…..*all over the landscape*……"

4 of the interviewees (PM1, ARC4, QS1, CON1,) attributed abandonment to relocation of the seat of the Federal Government (FS) from Lagos State - Commercial City (CC) to Abuja - Federal Capital Territory (FCT).

Each of the twelve participants were able to mention abandoned infrastructure identified in different parts of the country. PM1 considered all these buildings as assets (that must not be wasted) to the government, while ARC 10 considered them as "waste away" and can be put to use as noted by QS2; some developer do "*help getting the project salvaged from being abandoned, put to use with facility from the bank, with very good arrangement of repayment…*"

PM1, QS2, ARC 4, QS1, CON1, CE1, ARC 2 and BU stated the reason for abandonment as the lack of proper or adequate planning. The attempt of the researcher to obtain further clarification from QS1 on what contributed to the abandonment in Nigeria was futile, as the participant withheld information such as other factors that could contribute to the abandonment.

CON1 considered the awareness of abandonment from the perspective of being sensitive to the environment and being eager to facilitate restoration at any slightest call by the government – '*You can't be in our industry and miss abandoned buildings*'.

3 of the participants, such as ARC 1, ARC2 and CE1 agreed that abandonment is both a public and private sector issue, while CON1 adopted a contrary opinion stating that the occurrence of abandonment is largely with the public sector. 70% of the interviewees considered abandonment as a waste of resources. This ARC 2 advocated for a mindset reorientation in the country as a resolution to abandonment. Hence, the need for "*mental re-orientation"* is required to address the home owners who develop without "*proper procedure… without making sure that this building is been approved…. In UK now, for instance, you can't build a structure without the structure been approved*".

CM1 was also involved in projects that have been abandoned and has published in different journals narrating the experience with abandonment, such as kidnapping and banditry issues, inexperienced contractor, and referred to a white elephant project due to funding. BU1 referred to abandonment as being experienced from the *military era*, but more prevalent in the civilian regime. Miltary era was a period of military rule by members of armed forces and who upheld order instead of engagement in political affairs (Geddes 2014).

Other causes of abandonment as mentioned by BU1 were faulty assumptions of political positions due to patronage, faulty project prioritization, frequent change orders, poor scope definition, inadequate budgeting, devaluation of currency, absence of physical and financial discipline, and insecurity. PM 2 mentioned other types of infrastructure apart from building. This participant defended the government for having good 'intention' to commence the project but later abandoned due to finance issues. ARC 3 latched onto the procurement process as the major cause of abandonment stating that procurement process is "*greatly flawed*", "*insistence on lowest bidder*", "*manipulation*", "*greatly destroyed*", "worse".

QS 2 was of the opinion that government should learn to stage partial completion in case of shortage of funds (Canham 2019).

4.3.3 Sustainability highlight during the interview.

To ascertain the mindset of the participants about addressing the abandonment issues from a sustainability point of view, the participants' understanding of sustainable development must be determined. The interviewees expressed their understanding of sustainable development from different perspectives.

PM1 viewed sustainable development as a need to preserve, and avoid pollution of the environment and having any "waste of value" (economic). The interviewee lamented that repairing a building as if the building is being reconstructed, risks losing money in the process. While the first interviewee was vocal about the contribution, QS1 was not expecting this type of question as she stated "*You put me on the spot now*" and that shows that she was not fully prepared for such a question on sustainable development or could be a very cautious individual. QS 1 initial hesitation towards this question was respected as recommended by CUREC (2020). The eventual response to this question was "*have*

competent hands…" This participant referred to consultants and contractors who are not able to provide detailed designs due to incompetence. These challenges as stated by QS1 result in further challenges such as scope creep, inadequate pricing, cost overrun and eventual abandonment.

Moore et al. 2002 and Giangrande (2019) defined competence as a functionally connected web of knowledge, attitudes and skills that facilitate effective problem solving and task performance. According to Guia (2020); Annelin and Bostrom (2022), major competences in sustainability provide the individuals with the essential competences to proffer solutions to complicated problems and utilise prospects in favour of sustainability. These authors further affirm that modern competences as opposed to ancient competences are required for professionals, communities, citizen and consumers and society at large to tackle these sustainability issues and develop a new paradigms that can result to global sustainability. On the other hand, CON 1 consider the question on abandonment as "waste of resources" (and mentioned '*value*'). He advocated for the buildings to be put back to use for "*conservation of resources*" or for "*generating revenue*".

From a different perspective, CE1 viewed the question relative to pollution, quality of air, water, reusable materials, and the environment. The understanding of the interviewee is that sustainable development is "*a great effort….. never been, or brought to bear in developing nations of which Nigeria is one*". This could be attributed to the fact that "*natural hazards and disasters hits the advanced countries way more than our particular situation in Nigeria*". The interviewee is of the opinion that the government and the citizens should not allow political reasons or influences to obscure effective "*decision making*". For instance, "*When i'm building a dam, am I building it out of political reasons or am I looking for, where the channel is the shortest so that I use the shortest of materials*."

ARC1 reflected on the clarity of the triple constraint (definition of cost, scope and time) in project management and sustainability and called for the articulation of projects to avoid failure or abandonment. "*Most infrastructure facilities in Nigeria do not qualify to be called projects*. *And so, when if that is the case, then it means that abinitio they are already destined to fail*". According to PMBOK (2017) "*A project is a temporary endeavour undertaken to create a unique product, service, or result*". Possibly related to the definition of a project as having an end - infrastructure (generally) has an intermediate end point, so it is possible to argue that building infrastructure is just one stage in an indeterminably long lifecycle.

On the other hand, ARC 2 claimed sustainable development to be " *a broad topic*", the interviewee understood that "*sustainable development is……about how you can build a, a structure that will foresee the future, you know that will stand to time….that won't be an environmental disaster to the whole society, you know*". This contribution advocated the use of environmentally friendly materials, with not just the aesthetic consideration, but the composition of the material. The interviewee also advocated for "*mental reorientation"* as awareness strategies to start informing the citizenery of the need to understand the importance of the concepts.

With optimism, CM1 considered "…….*sustainable development…….. a peaceful atmosphere"*, when provided by the Nigerian government. Sustainable construction can be experienced in the country when a funded project is completed as agreed and commissioned. To experience the positive impact of sustainable development, BU1 equated it to the need to have economically viable projects with appropriate scope definition using "*a home-grown technology*". This should be void of "*politicized appointment of policy of stakeholders*". PM2 recognised the "…..*sustainable development goals…….as set up by the United Nations and the Nigerian government is aware*", the government effort to "*support those sustainable development…….. for Nigeria and Nigerians*" and concluded this section of the interview as "*project abandonment can also affect sustainable development goals in Nigeria*".

In contrast to all the contributions aforementioned, ARC 3 categorically states that construction industry in Nigeria "*cannot be sustainable….. wasting….human and material resources…. with no progress….transparency…..total sincerity of purpose and commitment*". Toriola – Coker et al. (2021) also identify the barriers to sustainability in Nigeria construction practice, listing some of the factors as lack of incentives for design team to facilitate sustainable design, poor awareness on sustainability education in the academic institution and considering other issues as priority rather than sustainable construction issues. This is supported by Davies and Davies (2017) claiming that the present construction practices in Nigeria are unsustainable, and not in alignment with the standard sustainability principles. The connection between interview statements and literature posit that further awareness strategies would help to enhance sustainability implementation in Nigeria.

QS2 viewed sustainability from the perspective of a reliance on natural lighting and ventilation of buildings. "*Sustainability should be a key in any aspect of design most especially in this part of the world where power is problem, where older infrastructures are in problem*".

In conclusion, ARC 4 briefly summarised sustainable development as the need for "*sincerity of purpose*" and an articulated "*legal framework*".

4.3.3.1 Qualitative Content Analysis

To employ the qualitative content analysis, It is worth noting that about 70% of the participants in this qualitative data collected and also from literature review in Section 2.3 referred to abandoned infrastructure as a "waste". Moreso, waste generation (C4) and government regulations (C9) which were identified in the list of criteria in Chapter 2 also informed this analysis for further findings. This section pointed out the attributes of these concepts (rethink, reduce, reuse / resell, refurbish, regulation) from the interviewees' responses in Table 4.14. Hence, Table 4.14 was coded to obtain the participants' thinking around the multiple 5Rs concept waste management of abandonment.

Table 4. 14 : Organised Coding of the 5Rs Concepts

No	5Rs	Participants
R1	Rethink	PM1, CE1, ARC1, CM1, BU1,
R2	Reduce	CE1, ARC1, CM1, PM2
R3	Reuse	PM1, QS1, CON1, ARC1, BU1, PM2,
R4	Refurbish	QS1, CON1, ARC1,
R5	Regulation	CE1, CON1

The further discussion and the identification of the 5Rs as mentioned in Chapter 3 are discussed in the sub sections below with each subsection annotated as R1 to R5.

R1 - Reasoning for a change (Rethink)

The most sustainable manner of redeveloping the abandoned infrastructure is to rethink the action taken by the government and individual professionals in the public sector. Almost all the interviewees mentioned or related to the need to rethink. This can further be regarded as thinking, rethinking, or thinking through every effort to redevelopment of abandoned infrastructure. BU1 stated that "*at a desperate hour like this, we need critical thinkers in government*". This require the decision and the policy makers to be engaged in cognitive exercise in providing critical solutions to the issue. The notion raised by BU1 was supported by PM1, who questioned, "…. *could the country afford the colossal loss? So, the first thing is to think things through*…". ARC 1 further pointed that there is a need to "*start thinking about how you can re-strategise the buildings*…. There are possible options available in

restrategising the structure for use. For instance, CE1 ruminates on *"how many accommodations that would provide, if we converted it to living quarters*", while CM1 provided a solution during the interview to resuscitating abandoned infrastructure through "*PPP…., that is what I think*". These interviewees have taken up the responsibility to think about the situation experienced by this abandonment and also call on the leaders to follow suit, as concluded by Dinika (2022).

R2 - Reduction of new built for existing structure to achieve economic gain (Reduce)

Reducing is an action in the next stage after rethinking. It is essential to reduce the development of new infrastructure that is not necessary, as argued by Pavlovskis et al. (2017) while focusing on readdressing the abandoned ones. With this in mind, CM1 affirmed that "*the economic loss will be reduced…. the level of abandonments ease-out*". PM2 also noted that balancing the development of new infrastructure with the existing abandoned "*can reduce the impact of reptiles, of animals around all those environments",* especially around the vicinity of the abandoned structures. ARC 1 supported this that "*once functionality plays into the role of the existing structure, it reduces your finances*." The negative effect of abandoned infrastructure is the waste of financial resources. CE1 opined that economic growth could be enhanced by illustrating how one of the major infrastructures in Nigeria can be redeveloped, for example, using "*the first two or three floors as parking and then the rest as just liveable. Just reduce, find a way to change the functionality*".

R3 - Adaptive reuse of existing infrastructure for economic sustainability (Reuse)

It is important to consider reuse not only for products but also for structures, especially the abandoned ones. Most of the interviewees mentioned different abandoned buildings that they are aware of and advocated for reuse or outright sale to private investors. PM1 saddened, "*look at the NEPA station at Iddo in Lagos, then find that is just there. It is not reused*". CON 1 also emphasised the need "*to put the building back to use. The second thing is that you are conserving resources if you restore the building and put them back into use*. Preservation and conservation of these buildings relate to the effort to "*make good use of these buildings since it is not being used for this purpose…"* as noted by ARC1. Conversion of these structures through adaptive reuse is supported by Petković-Grozdanovića *et al.* (2016) and QS1, stating that "*…if you can convert the structure to what you plan to use it for, definitely, you will rather convert…".* To ensure effective reuse of these buildings, BU1 called on the Lagos State government to "*forge a relationship with a Federal Government and see how those properties could be put to use*", while PM2 believes that Federal Government should "*Sell them off, a new investor will come and buy it and you use it for something that befits the entire environment*".

R4 - Regeneration of abandoned infrastructure (Refurbish)

Vizzarri (2020) identified the refurbishment of abandoned places as a response to the conception of a sustainable city. In embarking on this process, ARC 1 states that "*there are guidelines for professional inputs in refurbishing or renovating a structure*". While elucidating why buildings are vacated and abandoned by the Government, QS1 advised that "*projects that have been abandoned*" can be refurbished by engaging the service of developers. In the interview, CON1 affirmed direct involvement in projects that "*burnt out, but they have degraded to the extent that they had to completely refurbish*" them. Refurbishment will not only provide additional public resources to the citizenry but will also align with the sustainable development goals.

R5 - Effective adherence to constituted regulation (Regulation)

It is one thing to set the rules and regulations, and it is another thing to stick by them, as CE1 states that "… *it is not really that there was no regulation that I referenced, because nothing was regulating*". CM1 advised that "…….*we must look at the regulations*…". There is a need for government to adhere to the regulation. The systems experience duplications or gaps in regulation resulting in Fadason et al. (2017) calling on the Federal Government to see the effectual adherence to the regulations to avoid abandonment.

4.3.4 Addressing abandonment with sustainability in mind

The participants were required to explain their thinking behind the suggestion of "*the best way (with sustainability in mind) to address abandonment of infrastructure in Nigeria*"

The participants were very passionate about expressing their views on this question. Although this could be considered either a good thing, as participants could value being able to contribute to a particular research topic (CUREC 2020), or as bad thing leading to a non-typical research situation (Wiecek - Janka 2015). Nevertheless, the researcher endeavoured to manage the situation especially when the negative side of such behaviour is experienced during the interview. For instance, by steering the participants to the intent of the interview when they derail away in their responses.

PM1 recommended the need for reassessment for "*alternative use*" suggesting Battersea (power plant converted to residential and commercial building) in UK as an example. This could result from the expiration of the utility value of the previous users.

Change in government (short term interest) should not truncate the continuation of a project. There is a need for citizens to have a life cycle planning mentality as suggested by the interviewee. There is a need for a master plan for the project to be implemented within each tenure and those that are transferrable. The interviewee advocated for "*institutional framework*" that does not allow a project to be abandoned. There should be value evaluation (think things through) for continuity of the project from the predecessor to successor.

Credit sharing, or who takes the credit for the completion of the project (between the predecessor and successor), should also be considered. Proper orientation will enable the stakeholders to ensure changes in government do not hamper the completion of projects, citing the European *Channel Tunnel* which took several years to completion, managed by "*two or three governments"*.

QS1 referred to the importance of government taking planning seriously at the inception of the project development. The interviewee was not able to divulge/discuss some information that related to the government, stating that government needs to verify the commitment and the will to do the project as most of the abandoned projects belong to the government. Joint ventures with the government to convert some of these structures. e.g Federal Secretariat to a block of flats or redevelop/ refurbish to office complex, was considered.

Having earlier mentioned improper planning during project implementation and political contribution. **CON 1** stated that planning can enhance facility sharing for "*generating revenue*" to avoid abandonment. Budgeting issues especially can also be addressed especially when not backed up with payment to reduce abandonment.

CE1 also referred to the Federal Secretariat (FS) building (one of the abandoned infrastructure assets in Nigeria). The interviewee compared it with another example of a block of apartments in Lagos Nigeria known as "1004 Estate Apartments" that was redeveloped by a private organisation, as this is

an example that suggests the conversion of Federal Secretariat (FS) to living quarters for accommodation requires cooperation between the Federal Government and the state Government.

Another option is for federal Government to sell it off to entities such as United Africa Company of Nigeria (UAC). Hence, to convert the FS into living accommodation, the interviewee emphatically states a need for overhauling of the facilities such as more parking spaces, efficient elevators with maintenance culture, clinics "*because we want to change the functionality to a new functionality*. *Now, you would think again about the design, that place was designed for office complex. The loading for an office complex is different from the loading of a building, a liveable building*." The first 2 to 3 floors can be for parking and expand on other services including sewage and ensure that the building is run on natural resources. The interviewee's concern is the issue of who takes "credit"? The credit issues may not allow politicians of the day to get it done. The credit issues are the same as credit sharing mentioned by **PM1**.

ARC 1 view is for the definition of the use of project "*From conception*" to be clear. The approved change of use which includes "*remodel*" or "*retrofit*" (including "*eventual occupation*") by adding some "*technological innovation or material changes*" will curb abandonment. The interviewee also laid emphasis on the need for the input of the eventual users into the retrofitting or any other redevelopment strategy to meet their expectations. For occupied and vacated buildings, the need to provide residential accommodation for the growing population should be a concern to address abandonment. Unfortunately, "*when a building is not properly executed, people will not occupy it……. because it is not meeting certain needs which may be cultural, social, which may even be security, which may be even safety issue*".

The interviewee continued by suggesting PPP "*Even if a times, the government may not be able to finance the facility wholly, then private participation can come in*" as stated in the previous data collected. With "*community involvement*", the private stakeholder will not only "*help in sourcing for the fund, they will even help in protecting it……..community participation is very important in sustainability"*

ARC2 mentioned "*restructuring and restrategising*" as the response to addressing abandonment in Nigeria. For instance, a ferry terminal that was not "*used for the purpose*" with the interviewee's personal assessment "*can be a town hall meeting because it's an open space……or an event centre because when you look at that environment there's no event centre around that environments……the facility begins to add to the economic growth*" …….. "*that's where restrategising comes in*".

Restructuring can occur when abandoned facility such as "*multi storey building……..abandoned by the Federal Government…….be converted into academic complex*". The interviewee further said that the consideration "*helps with budget management…return on investments in that structure*".

The need to imitate the achievement of the developed countries was highlighted by **CM1**. "*We need to go back to what was done in the UK*" with reference to implementation of Egan report and Latham report in the construction industry. The interviewee states that despite the existence of adjudication in Nigeria, there is no "*construction adjudication*", "technical construction court (TCC)" which the integration of "*Egan report*" can initiate and be implemented.

The interviewee pointed out that "*PPP will be able to address some of these issues in the sense that it is going to ease the government of responsibilities of some of these infrastructural projects, moving the risk to the private sector*". On the other hand, **BU1** regarded the need for sustainable redevelopment of abandoned infrastructure as a wake-up call to the leadership of the country with

"*everything…..on leadership. A lot of people in leadership position are not prepared…. seen politics as a career*". The interviewee advised against "*primordial sentiments*" practice to attain the sustainability in the country.

The interviewee suggests alternative use of some of the abandoned infrastructure, such as Federal Secretariat "*be turned to apartments….to condominiums…be sold to the public".* The interviewee stated that government should consider the "professionalism" criteria in allocating appropriate decision-making positions in the government as this effort can contribute to the issue of abandonment. The Interviewee suggest the "*environmental impact assessment (EIA)"* before carrying on remedial work on the structures such as the Federal secretariat to also know the mode of rehabilitation, "*because that place was meant to be an office*".

The participants further claimed that "Environmental Impact Assessment (EIA)" may not totally allow the conversion of the Federal Secretariat to a block of flats. The Chartered Institute of Ecology and Environmental Management (2018); Trinh et al. (2021), and Romo-Orozco et al. (2021) affirmed the assertion of this participant that conversion and structural works to existing structures can generate environmental impacts. An environmental impact assessment is advised when a building is set for conversion.

PM2 calls for "*Public Private Partnership Agreements with investors that are willing….. such buildings belong to the government……and if the government is not making money from that that building likely, their interest will not be there*". For sustainability, the interviewee then suggested that the building should be sold off to a "*new investor"* and "*then reinvest the money to another project that will yield value….. befit the entire environment".*

ARC 3 opinion associated with the question is to evaluate the "*Needs assessment*". "*If you need it, in the first place, you wouldn't complete it and abandoned it*". The further enlightenment is that the structure may be needed "*but the structure on its own cannot serve the purpose for which we need it and therefore the equipment, the furnishing, the everything that is required to make it functional was not part of the procurement process*".

Another thought-provoking view emerged from **QS2**, the cultural perspective/ background, consideration of end user, inflation and finally the "*phasing of the projects…… part of sustainability*" to generate income/revenue for the economic growth of the country or "*revisiting the initial purpose of the building to reflect present need creation of opportunities and best usage practices*".

ARC 4 request the government to look "*look outside the box. If the buildings are structurally fit, there's no reason why a remodelling of such to benefit the people,* should not be implemented. The interviewee further enumerated alternative use or change of purpose as "can *be remodelled to suit …to suit the communities…..can be converted into Hotel……event Center…… converted into offices, that is remodelling, and it will be sustained, well managed*". PPP was also suggested by the interviewee. Unfortunately, the interviewee states that obvious reasons for abandonment of some of these government structures is "*corruption, because sometimes when they allowed these projects to lack for a while and the integrity cannot be assured, what they tend to do is they will now recommend for demolishing. And, when they demolish and before you know it. They will buy it, they will acquire it for themselves for their own selfish use*".

4.3.5 Issues that critically underpin the consideration of abandoned infrastructure sustainability.
From the previous question, the interviewees were requested to further expatiate on other issues/criteria (Table 4.15) that result in or influenced the decision, or the opinion previously provided.

Table 4. 15: Consideration for abandoned infrastructure sustainability

s/n	Interv.	Comments	Assessment of the comments
1	**PM1**	Return on investment, purpose/benefit, deceitful leadership, "*livelihood savings in the cost of healthcare*".	The thinking of the participants is financially inclined
2	**CE1**	Familiarity with the FS structure with no structural defect. "*…adequate housing is always a priority for any government*".	Structural stability
3	**CM1**	Yes, revenues generation and return on investment	Financial inclination
4	**BU1**	The criteria for suggesting FS to "be used for condominium like block of flats" is due to the "surge in luxury apartment and demand for luxury homes and residential apartments in Lagos is huge". For FS, "we could use it for mixed development" with reference to China high-rise structure as an example.	Reuse and conversion mindset
5	**PM2**	"*One of my main criteria is the environment. Okay, The environment where that building (Federal Secretariat?) is located. It will not be nice to have a Company coming in to take that building as their head office. The place is highly developed and is highly inhabitable*". The interviewee state that a particular developer was discouraged by the Resident Association from refurbishing the FS to be occupied by a company with the understanding that residential development has taken over the vicinity over the years. So, offices development cannot be allowed. "*When Federal government build that building in the 1970s, all those areas were all bushes and nobody was occupying the place, it was no residential. But now, over the years, growth, development have taking place, people have bought those lands and they've built. They are residing there, and the area is quiet, It's a serene environment for the elites and now, you want to bring office there? It will not fly*".	Environmental sustainability
6	**ARC 3**	Effective need assessment should be flawless. This include the "*involvement of the right professionals at the right time is a major challenge*".	Professional competence
7	**QS2**	"*Change of use*" was the criteria considered in this context	Change of use
8	**ARC 4**	For residential purposes and housing units for families.	Housing needs

4.3.6 Suggestion/Method Applicability in another situation/scenario

The interviewees were able to provide valuable information on how to sustainably address the abandonment of infrastructure in Nigeria. Further questions were asked to ascertain if the sustainable/sustainability suggestion can be applied to other situations such as new developments. **PM1** being passionate about values systems in relation to sustainability during the interview, states **YES** "any *projects must have value it wants to delivered, and the value delivers must have a positive return on the investment made*" especially in area of government social responsibility. There is a need to avoid ploughing too much money in recurrent expenditures at the expense of capital expenditure to ensure sustainability.

The political leaders should also avoid "*Rhetoric and Promises*" by creating awareness of the understanding of development, economic and sociology in the political cycle. **CE1** confirmed the application of the suggestion in another situation provided that sustainable assessment of operation in place. **ARC 1** claimed that the response "i*s a framework or a principle that could be applied to other settings.* However, the constraints to adopting it to other settings will require further research or investigation on "*Community participation, culture, heritage"* and other sustainability attributes.

Having suggested PPP as the most sustainable solution to abandoned infrastructure in Nigeria, **CM1** claimed **Yes**, "*It has been discovered that PPP can be used in any economy sector, be it education, be it agriculture, be it, name it, construction.* The interviewee confirmed the capability of the Nigerian government on PPP and the existence of ICRC that ensures that "*all PPPs are being regulated in one agency".* Hence, the interviewee (from private sector) having been involved in mainly public sector project "*believed that the government can be able to ensure that we have good guidelines, good policies for this kind of PPPs in different areas that will work*".

With reference to the Federal Secretariat building as one abandoned infrastructure asset, **BU1** states that the sustainability initiatives mentioned during the interview can be applied to new development, citing similar facilities in ZenZen, China - a 33 storey building comprising apartments housing hotels and offices. **PM2** also claimed that there are "*criteria that cut across board. Anything you want to do, you have to check the environment first to know how the environment is, what is suitable you know before you can add any construction, what is suitable in that area so*". **ARC 3** viewed the need for "*holistic involvement of stakeholders"* for the suggestion to be applicable. Finally, **ARC 4** reiterated the support for the previous interviewee's point that **Yes** "*Collaboration is very, very important*".

The excerpt of the individual responses that resonates with the Federal Secretariat building and different alternatives as being the subject matter of this study are presented in Table 4.16.

Table 4. 16: Triangulation of responses to identify the pre-defined and emerging themes.

Response	**Ref.**	**Validated Quantitative Alternatives / Pre-defined Themes**	**Emerging Themes** Sustainability Attributes / Criteria <u>Functional</u> • Need Assessment • Infrastructure Audit
"The utility value for the previous users expired and therefore we need to convert them to new ones"	Federal Secretariat	Conversion	
"…..and the second thing is that if you restore the building and put them back into use, you are conserving resources…."	Federal Secretariat	Refurbishment	
"My question is 1004 is probably of equal size, with the Federal secretariat, so when you think about how many accommodations that would provide, if we converted it to living quarters,……"	Federal Secretariat	Conversion	
"There is nothing like even if you are changing the use, and its approved, and you want to remodel or retrofits by adding some may be technological innovations or material changes So, it must be guided by the approved principles."	Federal Secretariat	Refurbishment / Conversion	
"I think is a multi-storey building that has been that was abandoned by the Federal government, You know, It's still, been abandoned, you know such facility such facility can be converted into an academic complex."		Conversion	
"You don't leave it there, you have to look for a way to sell off the building. Sustainability, sell it off and then reinvest the money to another project that will yield value for you. Sell it off, a new investor will come and buy it and you use it for something that befit the entire environment."	Federal Secretariat	Selling off	
"11 storey structure, then it was planned to host the Kano state investment and property. offices and I think around 1987, the project was abandoned. For over 25 years.... To cut the story short, now it is A university" ".....So they use it as university building".	Federal Secretariat	Conversion	

If the buildings are structurally fit, there's no reason why a remodelling of such to benefit the people, you understand, it can be remodelled to suit. Your understanding, to suit the communities, so to say an office can be converted into, it can be converted into a hotel, it can be converted to event centre, and it can as well be converted into offices, that is remodelling, and it will be sustained, well managed and they need to also you know collaborate with private sectors.	Federal Secretariat	Refurbishment / Conversion / PPP Selling	

With the reference to the Federal Secretariat by about 60% of the participants, the building will be considered as a case study for the model development in Chapter 5.

NVIVO 20 was also considered appropriate as the qualitative data analytical tool. For instance, "*thinking*" as a concept discussed in, Section 4.3.3.1 and Table 4.17 appeared as an emerging theme and one of the most frequently discussed as seen in the word cloud. "Thinking" can be considered one of the multiple R concepts of "Rethink" as studied by Kirchherr et al. (2017) and Govani et al. (2021). BU1 recommended the need for critical thinkers in government and thinking is a huge responsibility for leaders to resolve this abandonment issues (Dinika 2022). Infrastructure development and abandonment by the government was also discussed at length during the interview. Despite the cluttering of these abandoned structure, Ogunnusi et al. (2021) recommend the government consideration of the social, economic, and environmental impact of redeveloping abandoned structure in the country.

The word cloud for the most recurrently used words within the interview transcript are presented in the Figure 4.9.

Figure 4. 9 : Word cloud (NVIVO) of the very often used word during the interviews.

Source: Author generated

Closely observing Figure 4.9, various themes are generated around government, abandonment, using project, buildings, thinking, sustaining. This can be triangulated with finding from the secondary data collection and the initial questionnaire from study two. From the same Fig 4.9, "*Abandonment*" appears to be the most common theme identified by the interviewees followed by "government" and "using project". These themes appear to be consistent with the findings of {Odutola and Adeniran (2017); Ariffin et al. (2018), Atamewan 2020}, {(Ogunnusi (2015) (2023), Amadi (2019), Nwannekanma and Gbonegun (2019), Okafor (2018)} {(Abdul (2018),}

Further triangulation of all these themes can be seen as shown in table 4.17.

Table 4. 17 : Interview statements around abandonment

Government	**Remark**	**Resp.**
"…when the federal government moved from Lagos to Abuja... they left a lot of assets…. not being put to good use…" "At the end of the day those projects lives are truncated, for whatever reason, and people start other ones, okay, so continuity of government…" "...Channel Tunnel, took several years, and I think two or three governments went through it, but they didn't abandon it at any point in time, ……" "…So, it's a project that if there's cooperation between the Federal Government and the Lagos state government….."	Relocation of government parastatal, Change in Government, Collaboration between different tiers of government	PM1, QS2, ARC4, CE1, BU1, PM2, QS1
The respodents PM1, QS1, ARC 4, BU1 all agreed that relocation of government seat is a contributory factor amongst others to building abandonment as presented by Wahab (2020). Participants such as PM1, QS2, ARC 4, and CE 1, believed that change from one government to another should not be an avenue for the successive government to abandon an ongoing project by the previous government. This believe confirmed the submission by Ubani and Ononuju (2013). PM1 suggests that motivation to complete any abandoned project should be instituted to avoid such abandonment. Furthermore, effective collaboration is critical within different tiers of government as noted by CE1, CM1. This was pointed by Muzenda (2018) Ogunnusi (2022) claiming that relationship with the two tiers of Federal and State government can unfold a pathway for effective reuse of these abandoned buildings.		
Abandonment		
"…An institutional framework that does not allow you to abandon it…."	Institutional Framework	PM1
"Whatever that political framework will be maybe you look at it again, you see how politics influences the sustainability or the abandonment of projects generally in Nigeria."	Political influence	ARC 3
"So, ever since i've been noticing abandoned projects all around most especially in Kano, where I grew up and I used to ask questions why are the abandoned?"	Observation from childhood	QS4
"…cos each government will want to do something that is unique in a way…"	Uniqueness in governance	ARC4
"So, they are all over the landscape, …we pay particular attention to those buildings that are abandoned…." "..You could divert the resources or direct the resources to completing these abandoned projects and using them and even generating revenue.."	Observation, Economic consideration,	CON1

"..because when a building is abandoned, you find out that People that are not supposed to be there are using those buildings for all kind of criminal activities.." "Boko Haram came in the northeast and with that we had to abandon the project till today as I speak to you." "i'm not saying that everything about abandoned High rises in Ikoyi, the former old Secretariat should be converted strictly to residential apartment. It could be for mixed development too whereby we have offices"	Nigerian context, Insurgence, Decision Making attempt	ARC2 CM1
The observation of these abandonment as noted by QS4 and CON1 actually support the intention to embark on this study. This is evidenced in Oyewobi (2017), Amadi (2019) and Abdul (2018) studies that considered littering and the impact of this abandonment as worrisome presenting the statistical information of annual loss due to this abandonment. Request for institutional and political framework were raised by PM1 and ARC 3 respectively to address this abandonment. This signifies not just a singular solution, but a holistic approach to tackling this problem. This framework was also considered during the literature review and authors such as Boateng (2015) and Goni (2021) also developed framework for their respective studies. This further informed the framework as an element with the overall title of these study. Vizzarri (2020) and Pavlovskis (2017) were among the authors that evaluated the solution to addressing abandoned structure with decision making support. The decision-making effort was perceived from the participants responses with different options to make good use of the structures as necessary.		
Using		
"..we need to put the building back to use. It is the same thing with conservation of resources…"	Call for Reuse	CON1
The need to put the building back to use as reinforced by CON 1 was also supported by Remoy and Voordt (2014) that considered adaptive reuse of unoccupied office buildings through conversion into housing apartment. Moreso, in case of demolition alternatives, Akinade et al. (2015) suggests that building components can also be reused or recycled.		
Sustaining		
"You know sustainability it's a multiple use word, sometimes we look at it in terms of environment, in terms of preservation, in terms of pollution" This simple definition of sustainability means activities that are serving a current population without jeopardizing the future generation. "..my advice is if you're not sure or sustaining that project to the end, from initiation to close out you go into private, Public Private Partnership Agreements with investors that are willing Okay, go into public private partnership.." "Whatever that political framework will be maybe you look at it again, you see how politics influences the sustainability or the abandonment of projects generally in Nigeria."	Sustainability definition Political sustainability	PM1 ARC 1 PM2 ARC 3

"You see, sustainability, you know it's like, the definition, let me just read to you. It is most often defined as meeting the needs of the present without compromising the ability of the future generations."		ARC 4
Sustaining is related to sustainability and most of the participants demonstrated good level of understanding around the concept of sustaining this existing structure. For instance, ARC 1 and ARC 4 actually defined the term sustainability as was also defined by Amiril et al. (2014) before proceeding with the discussion. On the other hand, PM1 further presented the understanding by segmenting the term into further element while PM2 provided an option as possible solution to the abandonment. ARC 3 contribution strongly present the need for further evaluation of political sustainability which was also adopted from Vizzarri (2020).		
Buildings		
"I personally don't know what has happened, but that's usually what happens when you have abandoned, Em, buildings that have been vacated and it is not occupied, it is either the government has moved out of the building to another state. So they are all over the landscape, you can see them and they are also because, we are in the construction industry, we pay particular attention to those buildings that are abandoned" "Now, you would think again at the design, that place was designed for office complex. The loading for an office complex is different from the loading of a building, a liveable building." "Okay infrastructure, not building now" "So the federal government can come, why don't you convert this building, pay us in a certain years of time, you know, take and convert it into this your academic complex that you are trying to, a university, you know" "the building is not there, the building is supposed to deliver for a head office or for a government agency, and they are still renting. "A lot of abandoned projects, you know in mostly buildings that have occupied and then later the occupants vacate and then they abandon it. A lot of 90% of such buildings belongs to the government"	Buildings	CON1 CE1 ARC 1 ARC 2 CM 1 PM2
The question from the interviewer was focused generally around abandoned infrastructure. However, some of the participants contributions were centered on abandoned buildings. This further support the assertion by Akande et al. (2021) and Adeyemi (2017). This eventually resulted to the narrowing of the scope of this infrastructure study to public building.		
Decision Making		
"But how often do we allow that to drive our decision making? Those are the questions that until we have enough people talking about it." "And those guided the decision of the project managers who now shared that with us before they determine, what was what, essentially."	Reflections	Ce1

"The loading for an office complex is different from the loading of a building, a liveable building." "..because that place was meant to be an office". "…allocating appropriate decision-making positions in the government…"		
Emerging Themes		
Thinking	Remark	Resp.
"You know at a desperate hour like this, we need critical thinkers in, government…." "In other words, and could the country afford the colossal loss of? What it is, So, the first thing is to think things through…"	Thinking	BU1 PM1
Refer to Section 4.3.3.1 for more discussion on this emerging theme.		
Need Assessment		
"The starting a project, abandoning it may not be due to poor need assessment, but when you complete a project. And you abandoned it that means you don't need it. If you need it, in the first place, you wouldn't complete it and abandoned it."	Needs	ARC 3
The need assessment was only mentioned by ARC 3. With critically consideration of the literature review this assertion was supported by Bradley et al. (2016), Amiril et al. (2014) and Morgan et al. (2018). Contrast to that Han et al. (2020) reference to "need" is a call to "significantly invest". The concern is that call for investment without the assessment of the need may result in abandonment.		
Infrastructure Audit		
"So the infrastructure audit, so every abandoned should be an audited".	Audit	ARC 1
Audit as considered by ARC 1 was only referred to by Okereke (2017) with the institution of Abandoned Project Audit Commission (APAC). This theme may not be worth reviewing further due to insignificant reference both from the secondary and primary data collection.		

From Table 4.17, present the triangulation of the pre-defined themes and emerging themes with literature. However, "Audit" would be dropped from further consideration due to their limited consideration from both primary and secondary data collection.

4.3.7 Theme Coding for decision.

All the participants mentioned different alternatives for addressing sustainable redevelopment of abandonment infrastructure (Refer to Table 4.16 and Table 4.17) as obtained from literature reviewed. There is an evidence of discussion towards decision making viewed from CE1 - *"But how often do we allow that to drive our decision making? Those are the questions that until we have enough people talking about it…."* and ARC 3 - "So, lack of holistic decision process…is a major challenge". More highlight on the decision-making can be viewed in (Figure 4.10). However, none were able to mention any appropriate process of achieving or arriving at the alternatives mentioned. Although some of the participants knew that there is a need for decision making to be taken to resolve this problem (see Table 4.17), none exhibited knowledge of the process of arriving at the best decision.

Having identified the TOPSIS technique to recognise the optimum solution in Section 4.2.6. it is necessary to develop a model that will be flexibly used by the decision maker to achieve the identification of an optimum solution without embarking on the mathematic calculations. Moreso, having undertaken numerous advocacy programmes and publicity by OSSAP -SDGs in NVR (2017), to enhance SDGs awareness across Nigeria, the decision makers are expected to ensure seamless policy integration. The OSSAP-SDGs is an acronym for The Office of the Senior Special Assistant on the SDGs. The SSAP was mandated to coordinate the SDGs – related interventions, to track the national progress and to report performance, and manage the operational processes for results. Hence the need for the development of a decision-making tool. Chapter Five discusses the development of the mathematical model structure which will then be demonstrated, tested, and validated in Chapter Six.

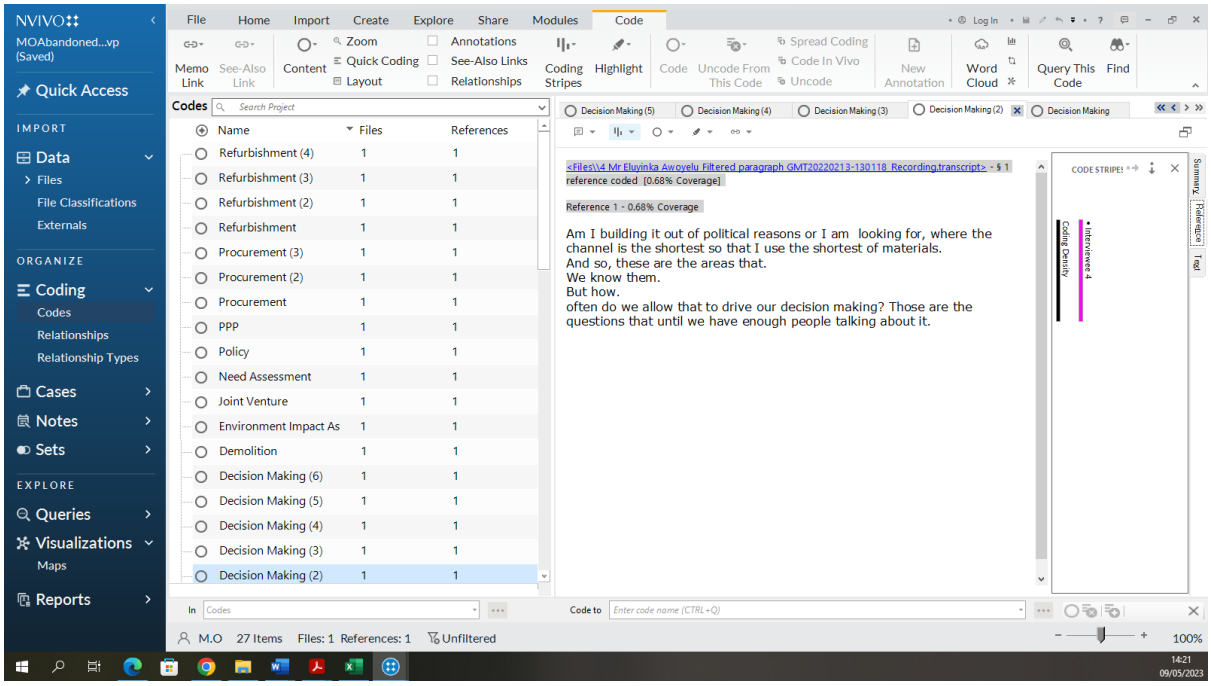


Figure 4. 10 : NVIVO 20 coding window

Source: Author generated

4.4 Chapter Summary

The data collection and analysis of findings with challenges encountered during the collection were presented in this chapter. It revealed the employment of a sequential explanatory mixed method approach of quantitative and qualitative methods including a case study to acquire a relevant data. The methods deployed for the first two sets of quantitative studies were questionnaires. SPSS descriptive correlation analytical tools were deployed to analyse the first questionnaire while TOPSIS technique was utilised for the second questionnaire. The qualitative study adopted Semi-structured interview with NVIVO for the thematic analytical tool.

The analysis of the methods with the aid of research instruments such as questionnaires and surveys presented some validated alternatives and criteria with sustainability consideration of economic, environment, social, technical, and political attributes.

The findings from the analyses especially from the interviews indicates that decision makers should possess systematic approach of identifying the optimum applicable and sustainable solution from arrays of solutions.

With this in mind, a decision-making model with embedded mathematical calculation and formulas will be developed in the next chapter to enhance the decision-making support.

CHAPTER FIVE: MODEL DEVELOPMENT STRUCTURE

5.0 INTRODUCTION

Building on the previous chapter, this chapter develops a model structure that can be validated by experts (through beta testing which is presented in Chapter 6) for the decision-making process of addressing abandoned infrastructure in Nigeria. The literature reviews and the primary data collection both pointed to the need for the development of a flexible and integrated TOPSIS Model (TOPMod) to enhance the decision-making procedure by the decision makers.

5.0.1 Model Development Justification

The sole intention of the model development is to identify and evaluate possible solutions in resolving abandonment issues in Nigeria. So far, the four studies within this research considered:

- the sustainability of infrastructure in Nigeria in line with the UN sustainable development goals,
- the possible causes of abandonment of infrastructure,
- the impact of factors contributing to the causes of infrastructure abandonment and
- the possible remedies of sustainable redevelopment of the abandoned infrastructure.

Three potential solutions (Refurbishment, Procurement / Selling off and gBIM) emerged from the literature. Also, from the literature review (Chapter 2), the identified criteria, and alternatives were also set. This study enabled the identification of the optimum solution out of the four alternatives and ten criteria as obtained in the literature reviews in Section 2.6. With the integration of these alternatives and criteria in this model, then this approach can be considered as a holistic solution (refer to Chapter Two Summary) to redevelopment of abandoned infrastructure. To understand the applicability of the decision-making model in addressing these abandoned buildings, there was a need to demonstrate it with a real-life public building. Hence, the Federal Secretariat building was selected as a single case study (Section 3.5.4, Chapter 4) for this purpose. This building was evaluated by Akande (2021) with SWOT Analysis to understand the strength, weakness, opportunity, and threat to the development of the abandoned Federal Secretariat. However, SWOT Analysis was not considered as a model in the contents of this study as noted in Chapter 2, section 2.2.2.

The participants were asked about what inspired the selection of the solution to address the abandonment as mentioned (Section 4.3.5) during the interview in Study Three, and different responses were received, including the influence of 'experience' in proffering a solution to issues. For instance, an interviewee (ARC 1) stated that:

"*Experience comes into play, you know because I've seen how abandoned buildings have been managed sustainably……achieved great use…, recycled…., renovates….. restructuring facility to be cost efficient*".

Despite the positive impact of experiences in this context, continuous professional development may also increase understanding and knowledge of innovation, evolving of trends in event, construction sustainability standards, and systematic problem – solving techniques.

The participants' responses raised concerns about the potential effects of poor decision – making on a project if the ideal solution is not found to be necessary.

Although there were inclinations towards understanding and knowledge of decision making during the interview as evidenced from CE1, CON 1 and BU1 responses in Table 4.17. This was not clearly highlighted during the response to the question on how to address abandonment with "*sustainability in mind*".

In any case, a step further away from provision of a tool as a solution to address a singular area of abandonment suggested by Olawunmi (2020) and Araszkiewicz (2016), there is a need for a holistic solution to redevelopment of abandoned infrastructure. It is important to establish structured decision-making frameworks and processes to help decision-makers approach problems systematically, reducing the likelihood of bias and ensuring comprehensive evaluation of options. The same manner that gBIM as a tool can address the refurbishment (at the initial stage of the planning – Section 2.3.4) so also in the same manner to objectively and systematically select the optimum option out of all options, should be made accessible for the decision-makers. This can be made further accessible to the decision-makers through the design and development of a practical model as a tool as suggested by Akande et al. (2021) in Section 2.6.3.

Anderson et al. (2015) affirmed that model validation infers the accuracy, reliability, and correctness of the model. In other words, there is a need to develop an appropriate and applicable methodology, create a physical channel to interact through, and to also ensure the applicability of the model to sustainable redevelopment of abandoned infrastructure in Nigeria.

Other studies such as Wilson (2013) and those mentioned in section 4.2.6 used MS Excel software to create a simple decision-making sheet in United Kingdom, France, Italy, Lithuania, India, and Germany. However, there was no indication that the decision makers in Nigeria were familiar with the usage, even from the literature. The participants were not familiar with it as well during the demonstration and testing of the model. This was evidenced from the positive responses to the need for the Decision-Making model as presented in Table 6.5. Figure 5.1 presents the construction of the TOPMod.

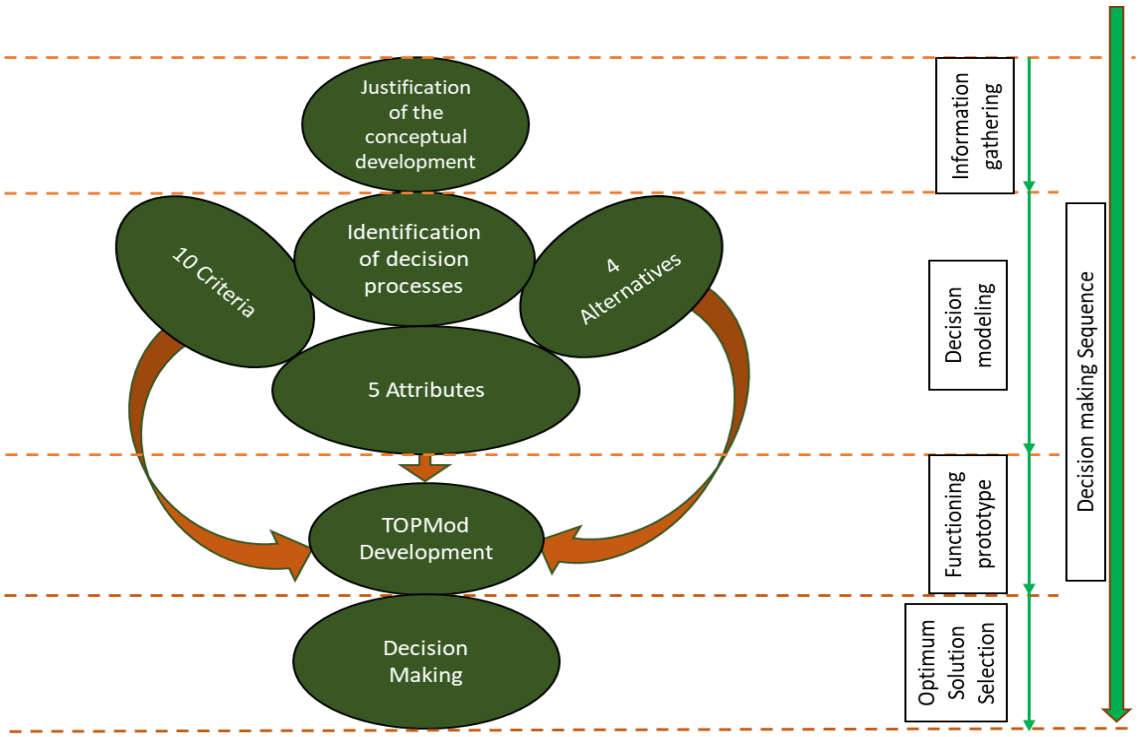


Figure 5. 1 : Conceptual TOPMod development

5.1 Conceptual TOPMod Development

The conceptual model is an academic and philosophical groundwork for the entire decision-making process.

All disciplines agree that a strong conceptual model is essential since it facilitates evaluation and data use (Lucas et al. 2013) or data / variables testing. The model will be developed by the researcher with the selection of options and scales of relevance that the participants will provide during the model demonstration. The following section will present the justification for the conceptual model.

5.1.1 The justification for the Conceptual design

It is essential from the onset to recognise the relationship between the processes of making decision(s)' and the incorporation of the MCDM TOPSIS technique. Some core elements of any decision-making procedure, as identified by Wilson (2013) and Taherdoost and Madanchian (2023) are a) the decision makers, b) the decision alternatives, and c) the consequences of the decision.

Focusing on the decision alternatives brought up two key issues for consideration: how the "decision space" was set up and the characteristics of the alternatives.

The first action was the configuration of the '*decision space*' which is basically the terminology signifying the combination of all the possible alternatives that could be identified within the decision model (Ramesh and Zionts 2013; Mota et al 2013; Taherdoost and Madanchian (2023). The '*decision space'* was designed to contain a finite (discrete) number of probable alternatives as contrasting to a hypothetically infinite (continuous) array of choices.

The second aspect is the characteristics of the alternatives, in that they are being measured by the existence of criteria which imply how well the alternatives can be measured as being useful or successful. Karunathilake et al. (2020) stated that diverse mathematical methods can be applied to the process. With that, the selection of techniques is achieved based on the characteristics of the issues and the extent of intricacy allotted to the decision-making method as all processes have advantages and disadvantages. In other words, 'criteria' within this context can be characterised as matters that are vital to the decision maker. The logical conclusions of the criteria and alternatives relationships within the overall MCDM method are captured in Figure 5.2.

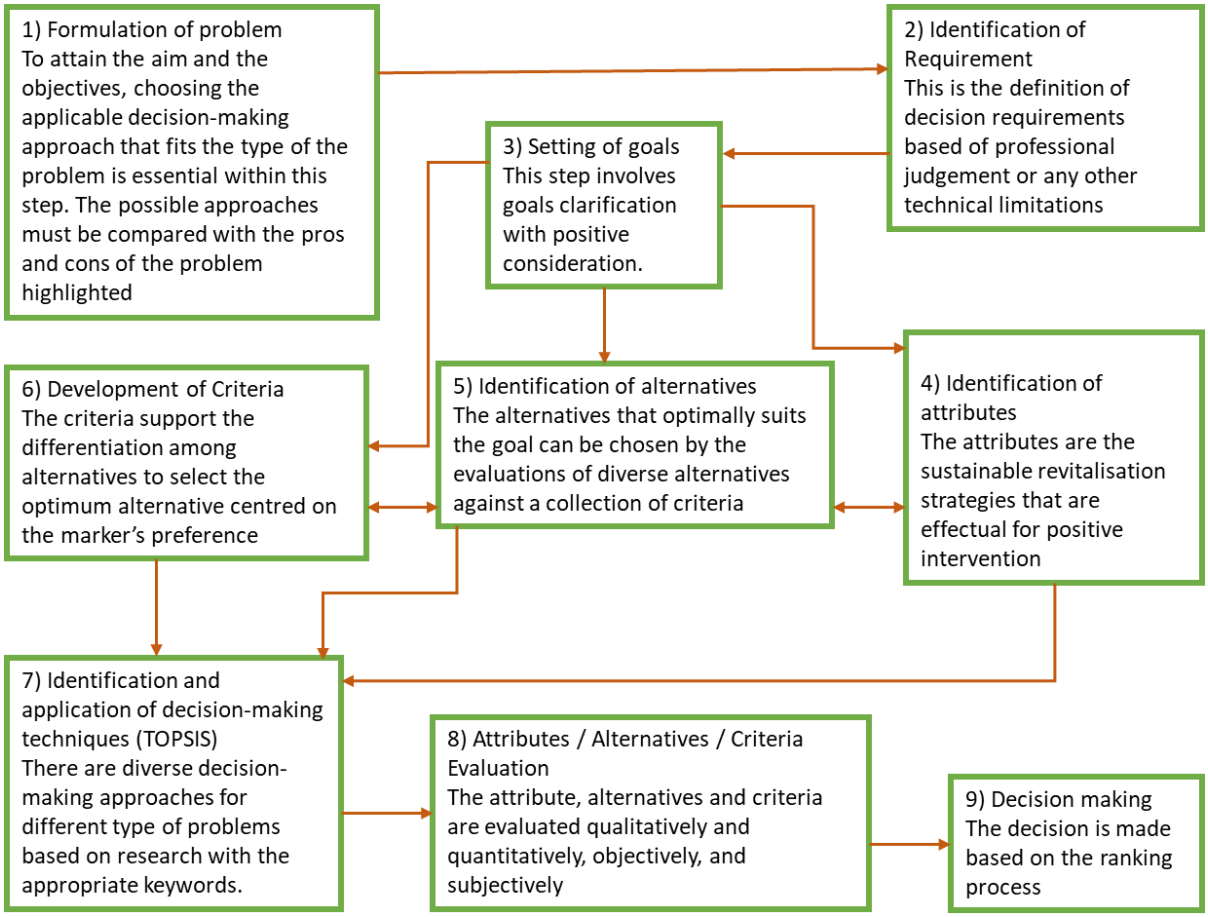


Figure 5.2 : Nine step MCDM process with flow of sequence

Nine step MCDM process (adapted from Wilson (2013) Sabaei et al., (2015), Karunathilake (2020), Vizzarri (2020) and Ogunnusi (2022).

5.1.2 Conceptual phases Development

Even though it is established that the complete decision-making model is a unified system, the 9-step approach described in Figure 5.2 has separate interface and iterative points as seen from the flow of sequence. This can be viewed from the steps in Figure 5.2.

Figure 5.2 presents the conceptual model in its complete form. However, there are essential information requirements, such as the identification of a problem and clarification of the goal in finding a solution to the problem, which must be pondered on within each of the nine over-arching steps. To some extent, the information requirements are static as the model collects and measures relevant alternatives and criteria. Within this context, the conceptual model focused on the process of the predominant decision-making phases as shown in Figure 5.3 and a set of generic or primary information requirements to fill in the choice of variables in each step as described. On this basis, each stage of the conceptual framework and the unified step is illustrated in the next section.

5.1.2.1 Information

This section summarises the prospective shape of the framework developed, and in theoretical terms, employs high level activities and actions related with the early building appraisal procedure in Figure 5.3.

The preliminary evaluation of the building (Case Study – Federal Secretariat, See Section 3.8.2.1) enhances the understanding of the building condition and appreciation of the essential performance prerequisite, while enabling the redevelopment plans, is crucial from the onset as shown in Figure 5.3 (Designing Building 2022). This has been previously reviewed in section 2.6.1.

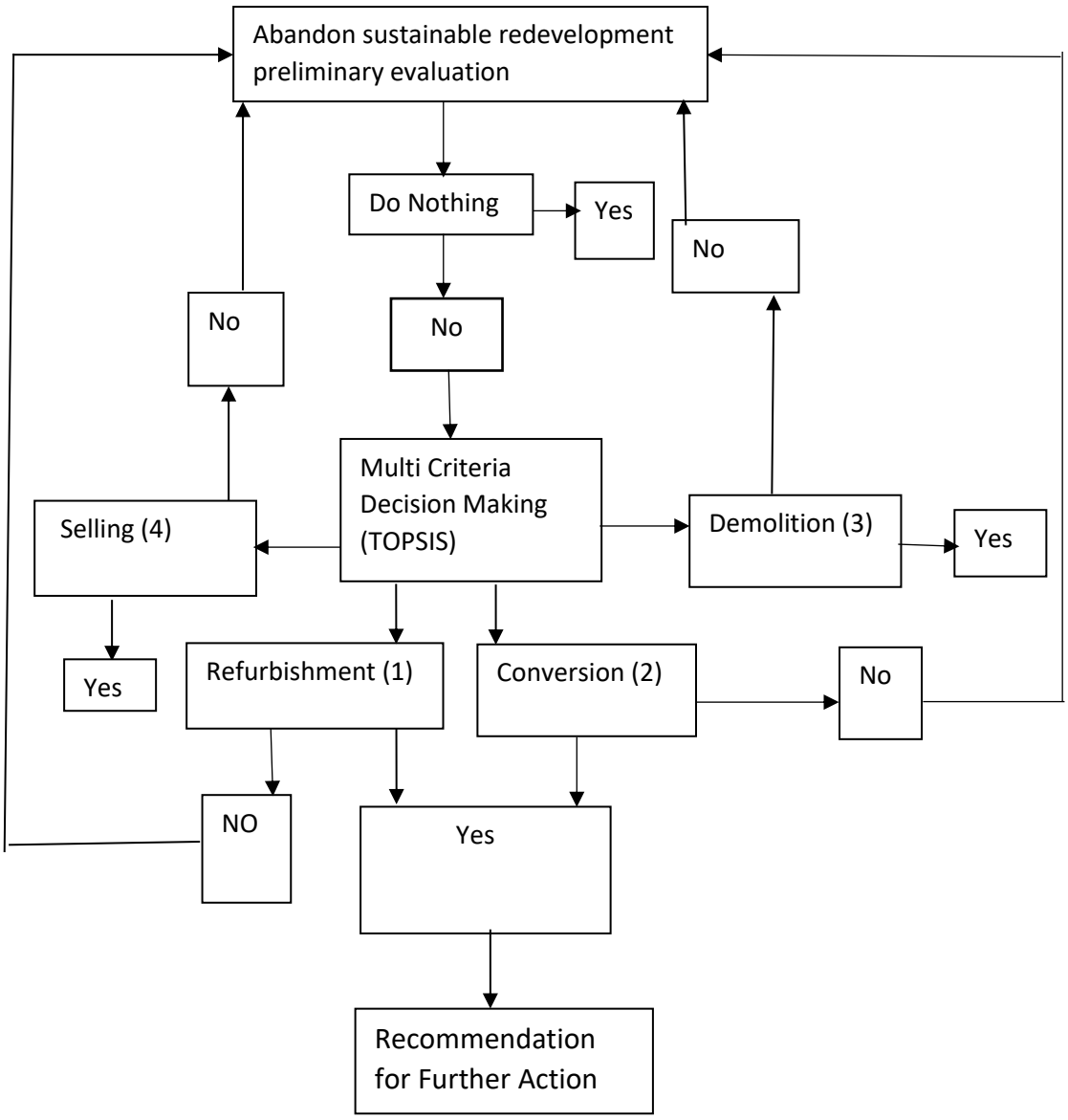


Figure 5. 3 : Integration of decision - making with the appraisal process.

Source: Author generated (Inspired by Kassem et al. 2012 and Wilson 2013).

The appraisal process as presented in Figure 5.3 is vital from the inception of the project, to ascertain the effectiveness of a proposal or a recommendation. Mac-Barango (2017) considers appraisal as a process of assessing or analysing a proposal. It often entails comparison of various options, by identifying the problem(s), evaluating alternatives, and assessing the proposed solutions against a capability to provide a solution. While some options may undergo a reiterative process of appraisal, some may be recommended for further action(s).

5.1.2.2 The decision development

It is within Step 3 that the MCDM process commences.

Ghorpade and Vasatkar (2015) also interpreted 'solving' as choosing a 'small set' of suitable alternatives or categorising alternatives into diverse preference sets. The combination of steps 3 to 6 is rationally placed within the decision modelling phase (see Figure 5.1). Each alternative is autonomously reflected on by means of the procedures shown in Step 2 (Figure 5.4).

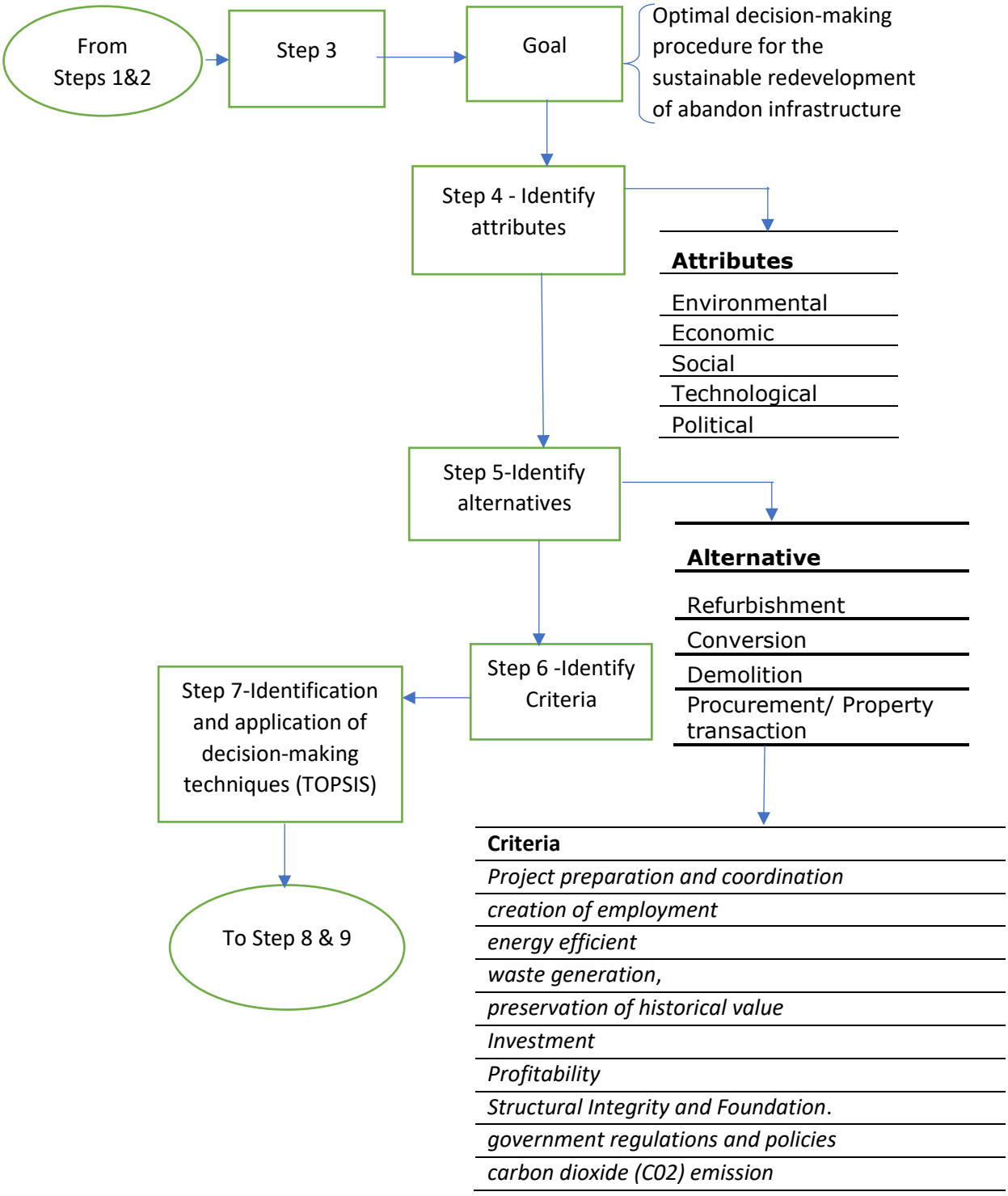


Figure 5. 4 : Decision making methodological framework.

(Source: Author generated)

5.1.3 Data Requirements

The initial point in developing an MCDM model is to initiate the main evaluation of alternatives and criteria which in turn enables the consequent mathematical structure of a weighted and ranked model. The study utilised Pavlovskis et al. (2017), Kabir and Hasin (2012) and Balioti et al. (2020) use of method, as stated in Chapter 4, to permit the subjective recognition of the alternatives and criteria as shown in Figure 5.4. The 'reductionist approach' will be undertaken to enable the recognition of a distinct number of identifiable alternatives. Duignan (2020) defined reductionism in philosophy as "a view that asserts that entities of a given kind are identical to, or are collections or combinations of, entities of another (often simpler or more basic) kind or that expressions denoting such entities in terms of expressions denoting other entities".

Identifying the data to be evaluated (Step 8) is adapted from Pavlovskis et al. (2017), Vizzarri (2020), and Mcguinn et al. (2020). Transferring the information/data over into (Step 8) attributes / alternatives / criteria evaluation was performed in part by the processes and activities defined in filtering and recognising the pertinent alternatives and criteria respectively. The supplementary data for Step 8 were more exploratory in nature. This is the principal stage of the MCDM procedure, whereby the participants reflect on the collated data (quantitative) required from steps 1 to 6 and apply (qualitative) data to present professional subjectivity into the procedure. The developed framework in Step 8 must then permit the mathematical procedure that allows the procedure to occur, fusing the qualitative with the quantitative, and the objectivity with the subjectivity.

For the criteria selection procedure, the possible number of criteria which may be summed up to any decision-making procedure could be substantial. The intent is not to try to encapsulate all of the criteria that pertains to the issue. To achieve this, all possible criteria must be identified before selecting the minimum number possible. Hence, the fundamental recognition of precisely, 'what' is being selected as the most pertinent and relevant to the subject matter is crucial (Wilson 2013). This strengthens the first step in the wider method of creating the model, which demands that the initial essential action is to recognise the problem goal.

5.1.4 Selection of Solution

Steps 4 to 9 involve identification and application of decision-making techniques. TOPSIS, a MCDM procedure is proposed as the 'Solution Selection' which must be viewed as the integrated method. This being so as it has an element of decision modelling and solution selection dependent on the nature and the size of the data collected, and project information essentials. The filtering method was conducted by selecting the feasible criteria (with sustainability consideration) from the three previously mentioned publications; Pavlovskis et al. (2017), Vizzarri (2020) and Mcguinn et al. (2020) and others (Refer to Chapter 2, Table 2.8) to arrive at the ten criteria.

The three attributes comprising of economic, environmental, and technological attributes were adapted from Pavloviskis et al. (2017), while the social and political attributes were adapted from Mcguinn et al. (2020) and Vizzarri (2020) respectively. To complement the mean weightage criteria calculation of 1/n (where n is the number of criteria), these steps of the model also implemented a process of Entropy Weights Method (EWM) (Refer to Chapter 2, Section 2.6.4, and Table 2.11) as substitute to compare each criteria against 'all other' criteria. Although the entropy weight method is known to be used for diverse machine operations, as studied by Kumar et al. (2021), it can also be applied for other development. For instance, Zhao et al. (2022) combined the entropy weight method with TOPSIS to evaluate the sustainable development of islands in China. Entropy (as discussed in Section 2.6.3) is an objective approach of weighting indicators by employing the theory of entropy

weighted value to evaluate the relative weight of each indicator. According to Qu et al. (2022), an entropy weights approach is generally used within an information weighting approach in decision making. The weighted assessment allocates the final weight of importance and will be clarified within the '*framework development*' element. The alternatives are then reflected on and ranked by the decision maker(s) (individually or collectively) based on the evaluation with the criteria weightage (Step 8). This will permit objectivity to be initiated into the decision-making procedure.

5.1.5 Implementation

The implementation stage leads the decision – maker to the stage of confirming the most sustainable solution for the abandoned infrastructure. However, the implementation stage may not be as simple as it may seem. At this point, it is worthy of note that when an alternative is being selected, within the method illustrated, using the completed model, the exact same method might be embarked on to obtain the best required choice within the provided alternative.

A typical example to further describe this might be that the alternative selected in Step 9 (Figure 5.2) may suggest that the most sustainable alternative identified for the resuscitation of an abandoned infrastructure is refurbishment, then there requires to be a recommendation for further action(s) or 'sub-action' (Refer to Figure 5.3) to determine the type of refurbishment. For instance, should it be a major repair work or 'cosmetic' (Designing Buildings 2023). Cosmetic repairs can be adopted on surfaces to fix scratches, chips, or cracks to an acceptable standard (Spindogs 2022).

The hierarchy (Figure 5.5) is suggestive of the model function in it is entirety and it is not essentially constrained to refurbishment alone but has the possibility to be tailored with ease in the usage from the complete system to the micro- element level. This is a major advantage of using a self – imitating rule-arrangement and method within the context of such a complicated and multifaceted building such as the Federal Secretariat as a Case Study. This model can be used with the precise same method to demonstrate the outcome of itself. Ferret et al. (2020) considered self-imitation as a pragmatic way of revisiting and reinforcing interesting actions. Likewise, Chan et al. (2019) also supports that innovation ensues after imitation. The micro – element level activities can be considered for future further studies.

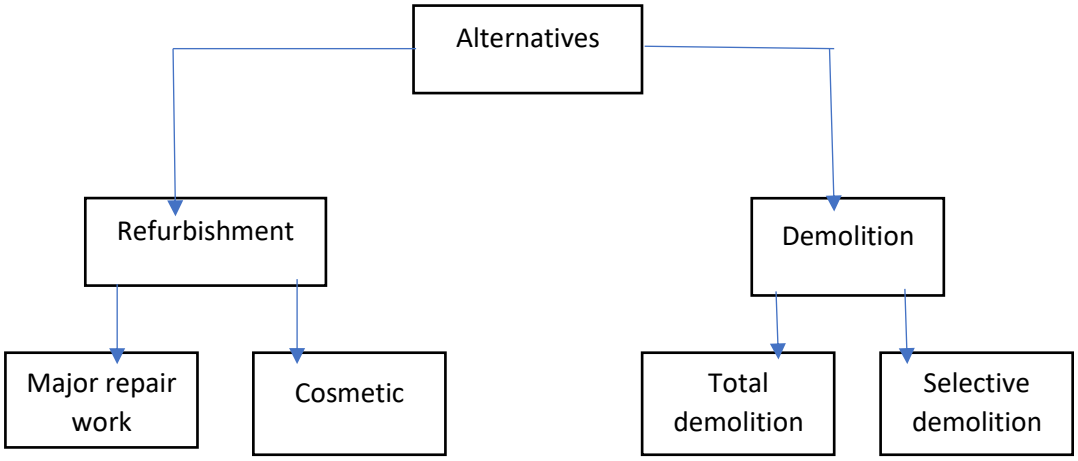


Figure 5. 5 : Hierarchy of complete and micro elements.

It is necessary to ensure that the relevant parties are involved in the identification of alternatives and criteria (options) and collations and assessment.

5.2 Operating Framework Development

In fulfilling the objectives of this research, the model development method advances and evidences a system that permits the conceptual model (Refer to Section 5.1) to be integrated into the MS Excel software-based model (Figure 5.6). The most inclusive and effective way of achieving this is through the adoption of the five sustainability attributes (Figure 5.7) social, economic, environmental, political, and technical (SEEPT) framework (Chapter 2, Section 2.2.2) devised through TOPSIS Model (TOPMod) to permit the synthesis of the "conceptual design" to the functioning model and decision-making model (DMM) worksheet (Zhao et al. 2022; Durmusoglu and Durmusoglu 2021; Roy et al. 2019). The most inclusive and effective way of achieving this is through the adoption of the five sustainability attributes SEEPT framework.

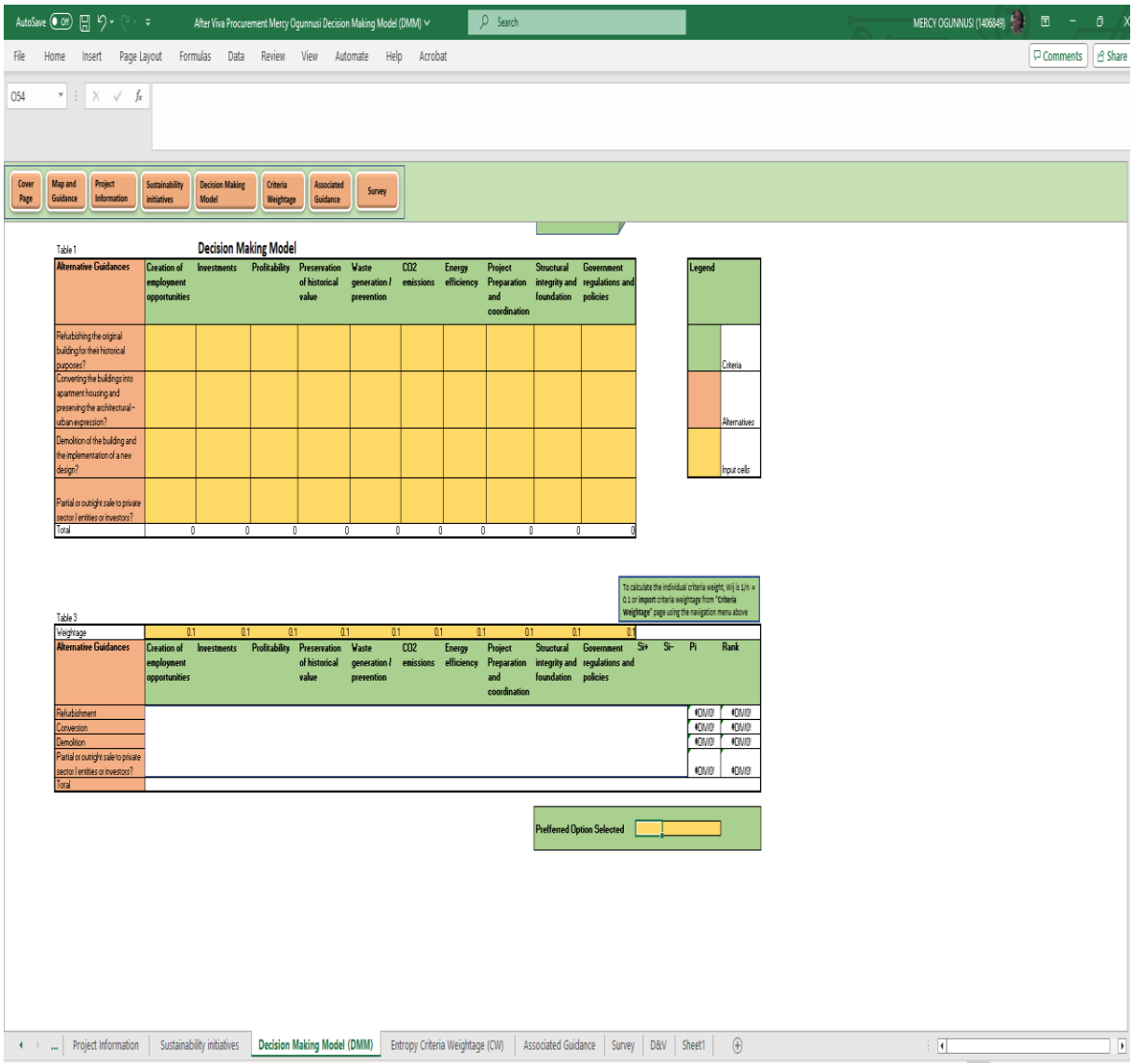
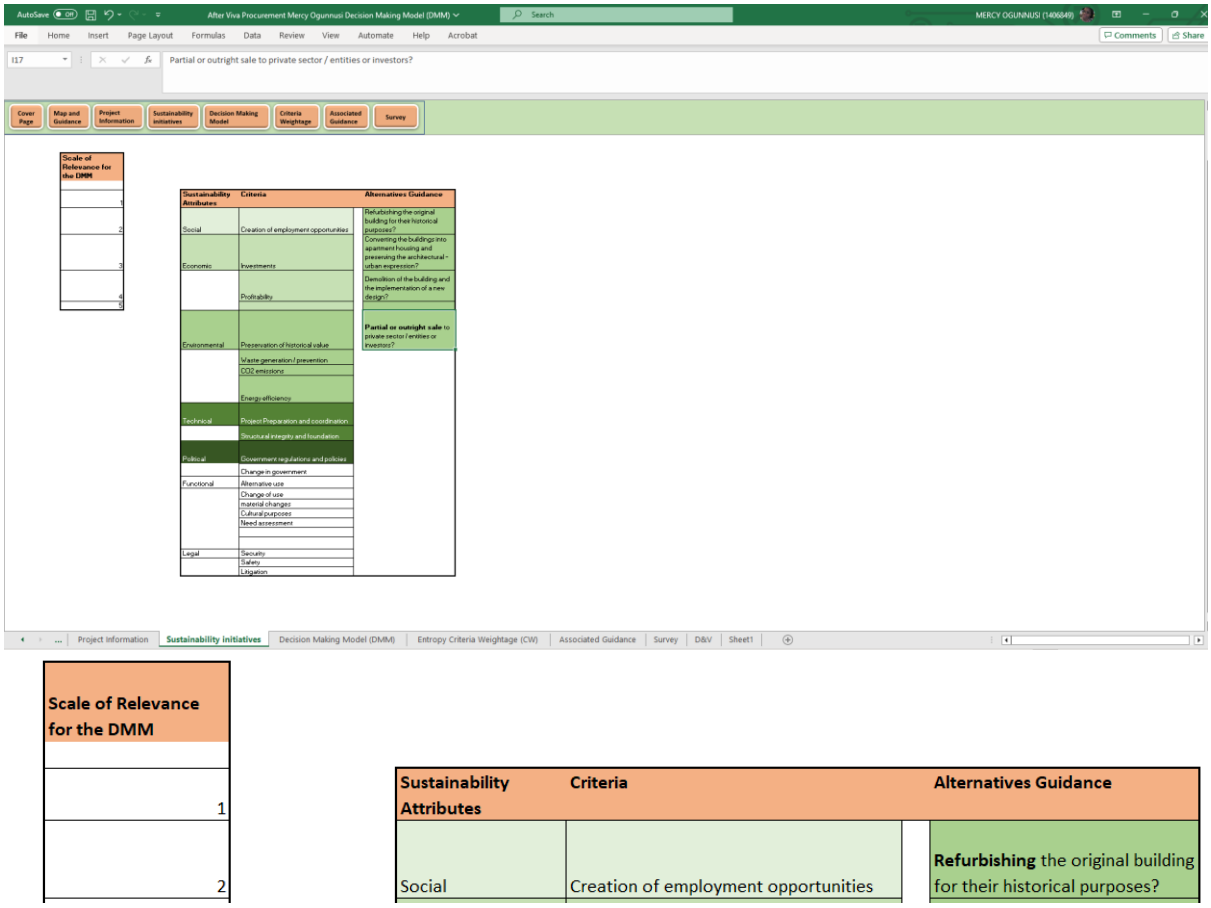


Figure 5. 6: Overall view of the DMM worksheet



Scale of Relevance for the DMM
1
2

Sustainability Attributes	Criteria	Alternatives Guidance
Social	Creation of employment opportunities	**Refurbishing** the original building for their historical purposes?

Figure 5. 7: A worksheet for five sustainability elements

Framework development proffers structured underpinning when developing an application to demonstrates *customized content* (Ghiani et al. 2015). It is the 'customisation' ability that provides the suppleness of merging the theory with the reality, the qualitative and the quantitative, objective with the subjective (Wilson 2013). Table 5.1 presents Sheth (2011)'s identified benefits of applying a robust framework.

Table 5. 1: Benefit of framework

Key Benefit	Categorisation of (additional) Benefits
Ease of Usage	➢ User friendly ➢ The user customization to a particular project ➢ Interface possibilities simplified
Comprehensive	➢ Descriptive Aspects ➢ Clarity ➢ Accuracy
Flexibility	➢ Facilitation possibility through the life cycle of the project ➢ Adaptability ➢ Suitability

Source: Adapted from Sheth (2011)

5.2.1 Devising the Framework

The model (Figure 5.6) has a scale of relevance (Figure 5.8) as discussed in section 3.8.2.4, using the following relevance ranking (Lin 2020):

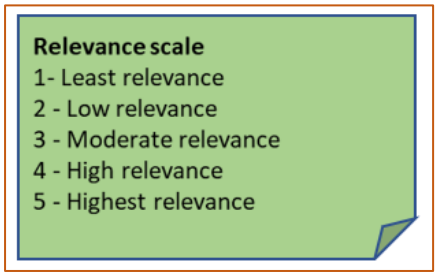


Figure 5. 8: Scale of relevance

5.2.2 The Criterion Function

Vivekh et al. (2016) compared each criterion pairwise comparison matrix (PCM) with each other and the relative relevance value was obtained. Nevertheless, Odu (2019) presented the mean weight adopted when the information is not sufficient, absent, or available to attain the decision needing to be made. For instance, W_{ij} for the calculation of the criteria weight is 1/n where n=number of criteria (Option 1). With ten (10) number criteria, the criteria weightage for each criterion will be 1/10, that is 0.1. Hence, 0.1 was written in criteria calculation weightage in each cell in Figure 5.9 (Option 1). Another (Option 2) of criteria weightage calculation for the effective demonstration of the model was presented in Figure 5.9. Figure 5.9 demonstrates how the calculation is expressed in matrix form in the model.

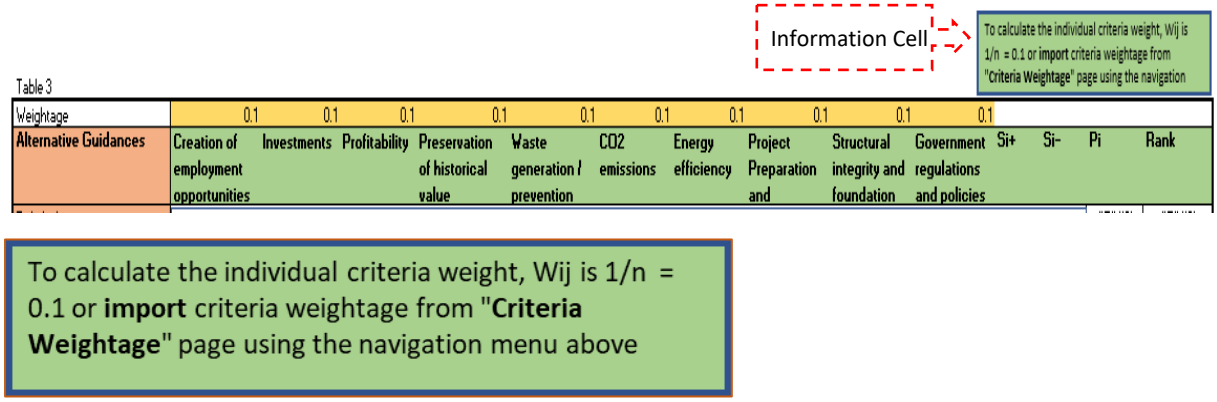
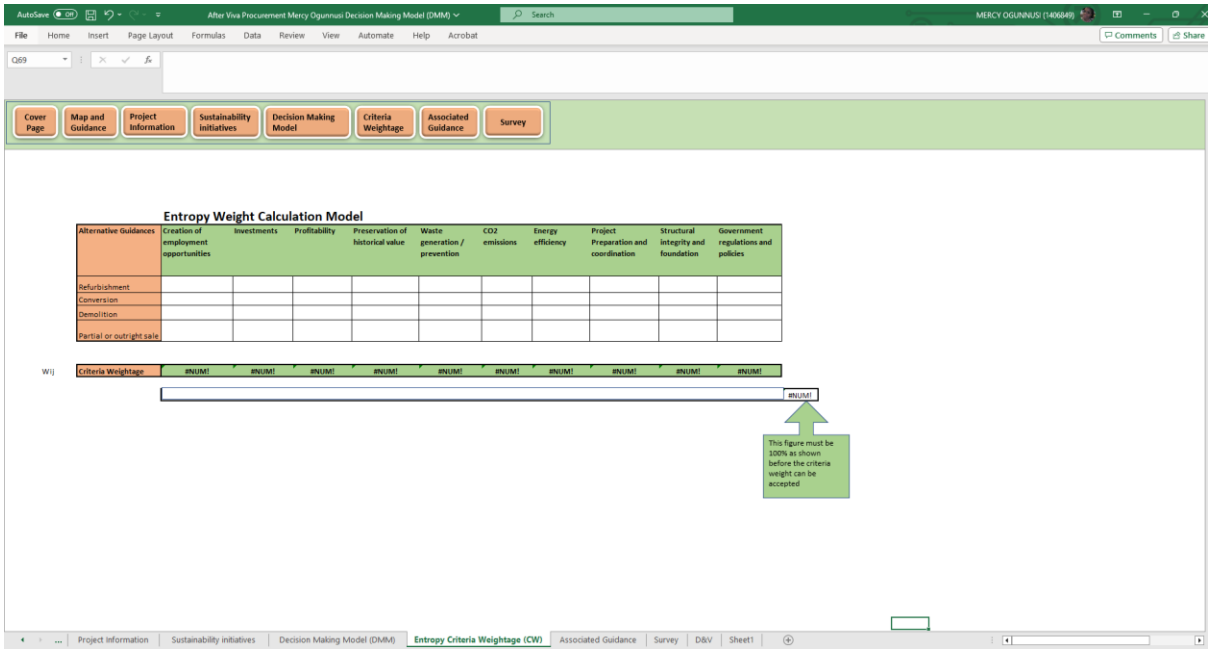


Figure 5. 9 : Criteria weightage (Option 1)

The example of weightage calculation with the entropy weight calculation (Option 2) is shown in Figure 5.10. Entropy weightage calculation by Mohare (2021) was adopted to supplement the initially mean weightage by Odu (2019) to exhibit the flexibility of the model. The entropy functions based on a predefined decision matrix.



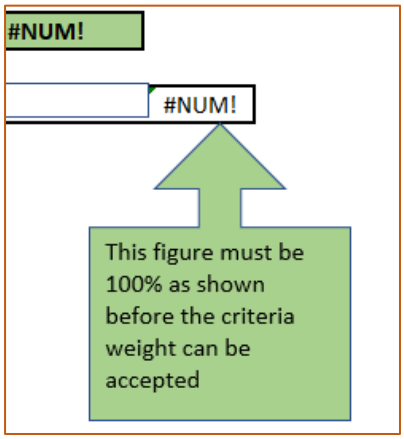


Figure 5. 10 : Weightage calculation worksheet with Entropy criteria weightage (Option 2).

5.3. Model Application to a case study

The approach regarding the conceptual alignment of the decision-making method, the framework development, and the related calculations and weightings are necessary to TOPMod as presented in Chapter 4. A case study has been employed to provide a context and a narrative to the working model and to bring the model development forward from the conceptual stage into reality. A model is imperative to illustrate the formats for data inputs, comprehend the user perception of the model and the examination of issues relating to the model (Nair 2008). Saad and Shaharin (2016) implemented the development of a system using a model to undergo diverse stages of the development of the model. Butter et al. (2014) also engaged in recursive process of expansion and routinization of education platform, linking model with piloting of a program. This method also permits the research to integrate components of the discussion stage all through the development stages. Hence, each step of the model was discussed in the User Guide in Appendix 13.

The User Guide is one of the four components of graphic user interface (GUI) (See the Glossary of Terms) that provides a 'walk through' for users of features, products or services and guides users on how to use the features (Gartner 2023; and Hayton 2023). In other words, the User Guide would provide guidance to the decision makers on how to navigate through the model.

From the onset, there are significant caveats to be illustrated regarding the usage of the developed model within the context of the chosen case study. Critical reflection of the study recognised the necessity to adopt the most prominent building (Federal Secretariat) referred to by about 60% of the participants during Study Three (Semi-Structured Interview – Chapter 4) (Refer to Table 4.16). Convincingly, this building also satisfied the three important factors:

1) Familiarity: A project that is well known by a large percentage of the citizenry, and more importantly by the participants of this study should be considered to ensure robust discussion during interview and overall data collection.

2) Current: Despite the length of abandonment of this public building in the early 90s, there are still public debate on this buildings as noted from Nwannekanma and Gbonegun (2019); Wahab (2020), Ayeyemi (2021), and Ayeyemi (2022)

3) Satisfactory in Scope: The project must be of reasonable value and size to rationalise the need for the application of the decision-making method.

5. 4 The Model and the worksheet

The model and the Graphical User Interface (GUI) will be portrayed in the framework of a case study. A GUI characterizes the key correlation point between the end users and the software elements (Mulders et al. 2022). It was utilised in an interface to model 3D Hydrological process of a soak-away rain garden by Mylevaganam et al. (2015). GUI were described by Rosenzweig (2015) as being composed of the following components:

- Windows: a component of the user interface that includes some of the information of the scheme. The window is the representation of the view and is part of a larger data system.
- Icons: Icons are graphical illustration of a concept.
- Labels: Title or name of a file or software function

All the worksheets are macros (protected) and some of them are devised to be duplicated as a blank template within the model, to permit for sequent sub-elements and elements to be reflected on for future further development of the model.

5.4.1 Sustainability Initiatives worksheet

This worksheet (Figure 5.7) comprises the collation worksheet for the attributes, alternatives and criteria required for the model development discussed in the theoretical and background development sections of this chapter. A filtering procedure was embarked on within the sustainability initiatives worksheet, to investigate and classify the most salient criteria necessary for the purpose of the demonstration on the case study. A filtering approach blends the concept of the 5-point Likert scale within the decision-making procedure (Chang and Ku 2021). This worksheet served two purposes:

- It served as the depository for all the drop-down menu contents / links for the population of the decision-making worksheet.
- It also serves as the database for all the sustainability elements needed for the decision-making space.

The drop-down menu automatically shows the contents as structured in the decision-making sheet, as can be seen in the screen shot (Figure 5.11):

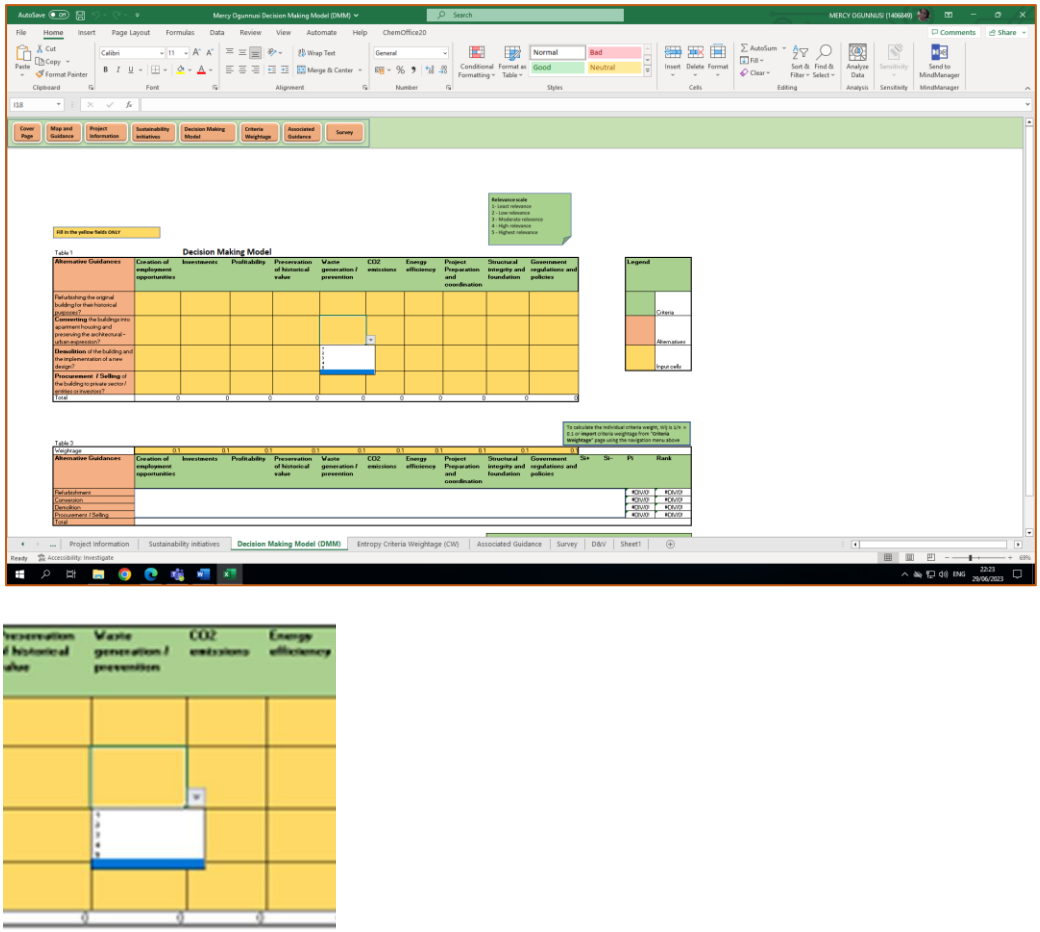


Figure 5. 11 : Validated TOPMod with drop - down menu

The sustainability attributes, for instance, comprise of the social, economic, environmental, technical, and political aspects of the discussion. Further attributes were realised during the semi-structured interview, such as functional and legal attributes (the legal attribute was also seen in the literature). Other contents of the sustainability initiatives include the criteria and the alternatives.

Alternatives and criteria (Figure 5.5), as shown in Figure 5.12 & Figure 5.13 respectively, were pertinent to the case study and have been identified through both the literature review and the semi-structured interview. The four alternatives and the ten criteria were adapted for the purpose of the decision-making tool applicability. The criteria selection can be reviewed in the future to accommodate other criteria as the case of project and can be adaptable to other projects when decision making is required.

The alternatives identified from the literature (Chapter 2) have also been considered as the working component of the model.

The decision-making process '*intended to be iterative in nature*' and as such, the alternatives and the criteria can be potentially improved and enhanced by presenting a starting point from a reliable data resource.

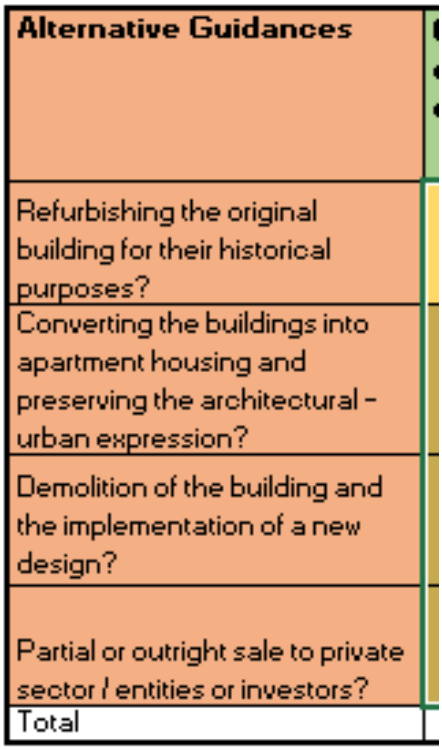


Figure 5. 12: Four Alternatives.

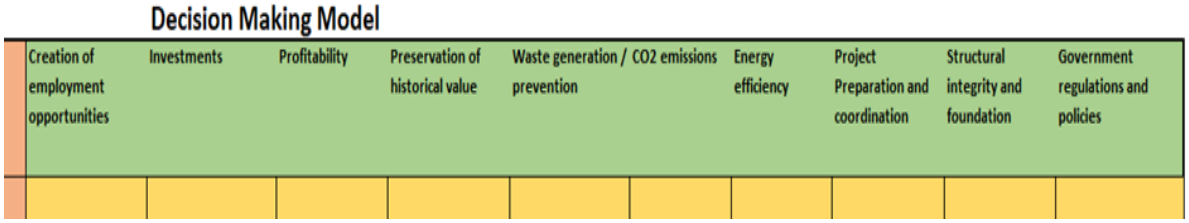


Figure 5. 13: Ten Criteria

5.5. Decision Making

The recognition of both the alternatives and the criteria by the working model has succeeded in the conceptual nine step MCDM design process (Figure 5.12, 5.13).

Nevertheless, Step 8 and Step 9 (alternatives evaluations against criteria and attributes and decision-making steps) respectively are the heart of the decision-making system, and these are fused into the 'Decision Making Model' spreadsheet of the model. The concluding Step 9 in the development of the

model focused on the development, testing and the procedure created all through the theoretical and framework phases.

The weighted evaluation process, along with the formula and calculations supporting the model page were altogether inverted inside the working model. This was necessary, as discovered in Wilson's (2013) study. Moreso, during the pilot demonstration of the working model, the feedback from the participants was to remove all the gridlines and formula bars of the MS Excel worksheet to enhance the graphical aesthetical view (in addition to functional view) of the worksheet.

The model is pre-set, with the help of the drop-down menu, to restrict the decision maker to a choice of the scale ranking (Figure 5.8). Rohmatulloh and Winarni (2014) and Zhao (2022) evaluated five criteria within the decision-making process, Nowogonska and Mielczarek (2021) examined seven criteria, Balioti et al. (2018) assessed nine criteria; Wilson (2013) appraised ten criteria. Roy et al (2019) also evaluated ten criteria with four alternatives. It should be noted that the total probable number of the criterion available to the participants /decision maker are maximal number of ten with a minimal input of two. The justification for the maximal restriction is adopted from Wilson (2013) and Roy et al. (2019). The MCDM method utilised is 'discrete' as opposed to 'continuous', and hence, deliberately, devised within simply workable restrictions.

This model can guide the stakeholders through the decision-making process relevant to 'rescuing' an abandoned piece of infrastructure. Within the model, these formulae and calculations have been automated with the aid of 'Excel formula function'. In other words, the model must possess integration capability into the Nigerian decision-making systems, especially with abandonment and redevelopment (Keriafe and Tiamiyu 2021; Agbo et al. 2013). A sustainable development should integrate economic, social and environmental qualities concurrently to work efficiently (Chong et. al., 2017).

5.6 Chapter Summary

This chapter described the structure adopted in the development of the model. The consideration for this includes the conceptual stage, the operating framework stage, and the functioning model stage.

This chapter justifies the decision for the model development with sustainability in mind. The nine steps MCDM process with flow of sequence was also presented to illustrate the application of the model.

This consideration for the conceptual stage includes the decision development, the criteria selection functions, the worksheets, the navigation, and the software platform justification.

The configuration of this decision-making system is to enhance a flexible decision-making process of evaluating the alternatives against the attributes and criteria with the aid of navigation tools and drop-down menus.

The model is expected to guide the stakeholders during the decision-making process. The subsequent chapter presents the test and the validation of the model.

CHAPTER SIX: MODEL TESTING AND VALIDATION

6.0 INTRODUCTION

The testing and validation are a critical aspects of the model development, therefore, an iterative method with a pilot study (Section 6.1) was crucial to enable improvement and feedback where relevant. It is essential, however, for the model to be tested and validated by potential built environment professionals or experts in the industry. The model testing went through stages of development: pilot and main testing. Quantitative feedback (scoring) and qualitative feedback (additional comments) from the participants is presented within the chapter to ascertain the user's experience and acceptance through beta testing of the model developed.

6.0.1 Key testing and Validation focus

The validation process, consists of three key areas:

- Efficiency of the model.
- Effectiveness of the working model
- User satisfaction

The testing of the model in respect to these three key areas was embarked upon by presenting the case study illustration to selected experts and working through the model worksheets in a methodological approach according to the pilot (Refer to Figure 6.1) and main stages (Refer to Figure 5.5) of the validation. It is of equal importance to note that the affirmation of these three key areas is presented in Table 6.3 Section 6.1.2 and Table 6.6 Section 6.3

At the completion of this process, the participants were provided with an opportunity to re-examine and re-test any facet of the model functions or design if desired. As soon as this exercise is considered and agreed upon as complete, then individual participants will offer scored feedback (quantitatively with the use of Likert scales) and further qualitative feedback as additional comment. The quantitative feedback enables the result to be statistically demonstrated to examine any variance between the expert panel findings.

6.1 Pilot study

It was considered essential to perform a pilot study of the testing and validation procedure preceding the identification and invitation of the industry expert/participants. The major purpose of considering the pilot study was to ascertain that any problems regarding the continuity or format of the case were addressed, if needed, before involving the professionals. The intention of the pilot study was to focus on the effectiveness and the functionality of the models in contrast to paying special attention to format and/or aesthetics. Figures 6.1 and Figure 5.10 clearly evidence changes and amendments from the worksheet as piloted and validated.

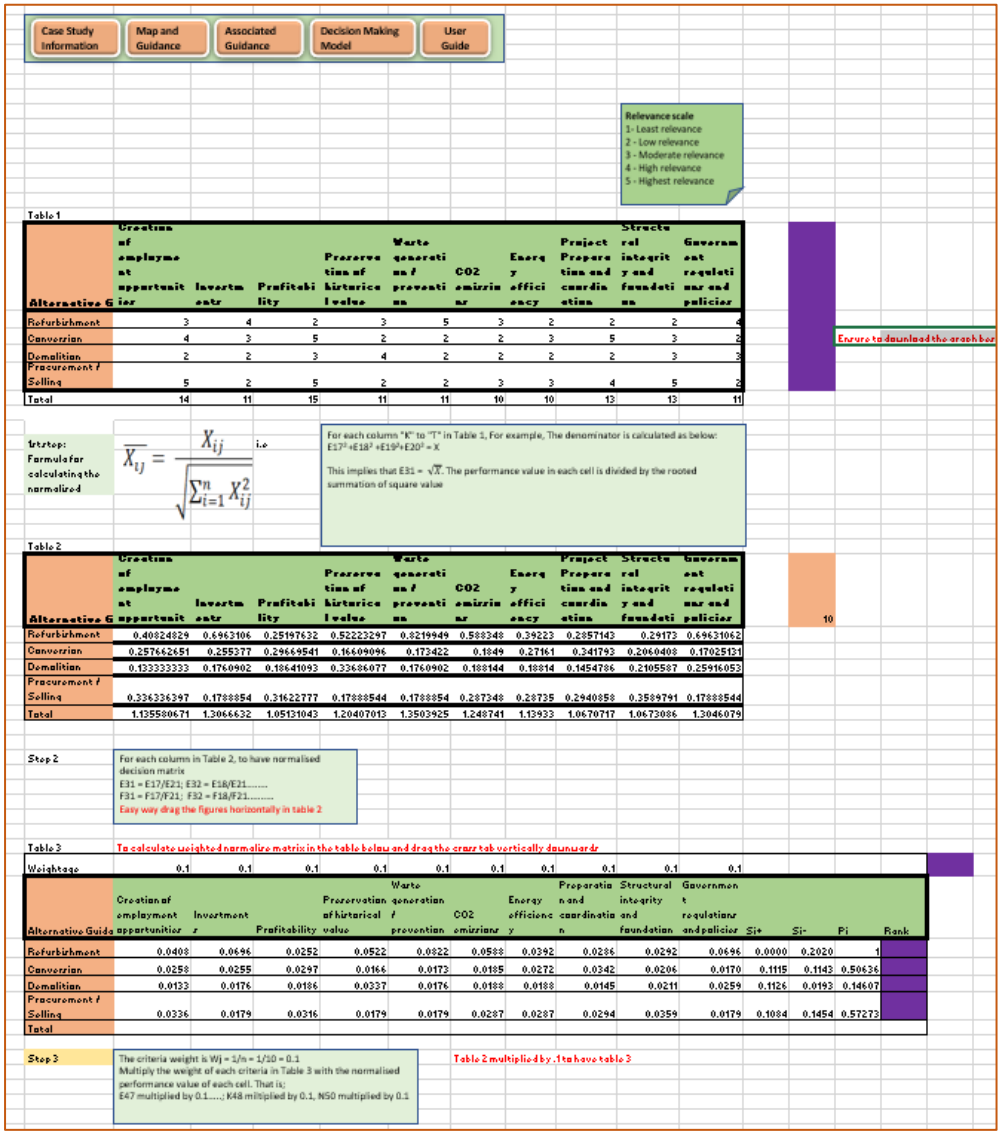


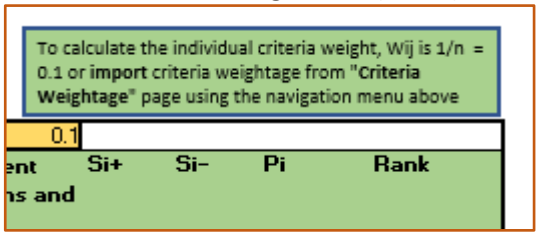
Figure 6. 1 : Piloted worksheet

6.1.1 Selecting the Pilot Study Participants

The pilot study participants were selected from a group of academics with competence in design, building, and management fields and professional credentials and experiences. Seven participants were contacted for this exercise from backgrounds including architecture, engineering, project management, construction project management, quantity surveying and town planning.

The objectives of the pilot study were to test the procedure with critique on formatting and the delivery as introduced in section 5.3. The pertinent comments from the model's actual use, together with any adjustment made for validation are presented in the Table 6.1.

Table 6. 1: Pilot comments

Participants Code	Comments by the professionals	Changes effected
PhD 1 - Engineer	"*In my humble opinion, If you want to follow one methodology in terms of your analysis, just follow one'.* The participant advised that the user should attempt the usage of the model more than one attempt to ascertain the outcome of the selection presented through the model. The participant also advised the removal of the "Associated Guidance" based on the challenges and constraint that the users may have in using it. Lastly, the participant suggested the application on one criteria (Option 1) (mean weight) calculation alone as against the additional (Option 2). Need for DMM. "*Yes, it is because it helps make an informed decision. And that would help to standardise the selection criteria for some of these projects, so yes indeed*". Outcome - Refurbishment, Conversion, Demolition, Selling	The participant advised against the additional (Option 2) criteria weightage calculation (Entropy weightage calculation) which complement the Mean Weight (Option 1). However, the options were retained for validation.
Research Fellow - Architect	The participant suggested the inclusion of the message 'Information Cell' below as a guide which was not there initially for the user to proceed to the 'criteria weightage sheet' for Option 2 if the need arises for Option 2 weightage calculation. Refer to Figure 5.8.(DMM)  Need for DMM. – "*Yes absolutely. I think it's really important to know how, what to do with abandon structure in Nigeria or any place and this kind of tool can really be useful for the decision makers, and you know like policy actors to take the right decision on how to do it. I will say yes, definitely*" Outcome – Refurbishment, Conversion, Selling and Demolition	The information cell was included for validation as suggested by the participant.
PhD 2 - Engineer	"*That column should have been automated to capture the rank of this values in terms of higher orders*". Need for DMM – Yes.	The ranking column was then automated as suggested to automatically ranked the alternatives.

	Outcome – Refurbishment, Selling, Conversion, and Demolition.	
Senior lecturer 1 - Town Planner	"*It can be improved in terms of the graphic user interface, that is the GUI, yea, you know. Many decision makers are not too much interested in statistics. They just want something they drag and, click and click...*" "*…the model is based on an Excel sheet interface, so, If we are going to improve on it, graphically, in terms of…. the graphic user interface…….the decision maker would not want to see an excel sheet. For the one that will go out to the decision makers, It's better you have…..the graphic interface that will hide the details of the excel sheet. Most programs that are written…. don't show details at the background… That is what I mean by graphic user interface, the GUI must cover the details, that is for the future*". Need for DMM – "*Yes, there is. There is need for it. You know one of the things I enjoyed in this process because decisions are made especially in this part of the world subjectively. No matter the different criteria you use, the politician who is in charge of the project would want to choose what he wants. When you put the criteria all together, what the criteria will give you may be different from what is in the decision makers' mind and that is, the model will help to overcome the concept of subjectivity*". The participants then cited the case of university library – UNILAG that collapsed due to bad decision making. "*It is good to have models like this that is going to be unbiased*." Outcome – Refurbishment, Conversion, Selling, and demolition.	The comment on GUI was considered and the worksheet was improved before the validation
Senior lecturer 2 – Project Manager	"*You have spread the number so much, me, I would have said that probably 1-3 is better because it is difficult to differentiate, because we can't put quantity to the number of employments. The question is, how do you differentiate between 4 and 5 for example– high relevant and highest relevant? It's subjective*". Need for DMM – "*Obviously, there is a need for it, but like I said at the beginning, in coming up with decision table, I don't want a decision model that will make things more complicated. It supposed to simplify it, not making it more complicated, but the point is there is a need for it".*	The participants referred to the need to reduce the five scale of relevance to three. The five scale of relevance was retained to provide flexible options for participants

	Outcome – Refurbishment, Conversion, Demolition and Selling	
PhD Student 3 – Construction Project Manager	"*I just want to call your attention to your colour coding before we go on further. Your colour coding should be exclusive for each aspect of functionality. Like from the beginning, you have some places that you need to type something, and you say the background is white, right? And here you have places where you need to select drop down menu, you have it yellow*" "*output should have separate colour from input.. that is, differentiate the output and input with different colours…'*. Need for DMM- Yes,.. because of the abandoned buildings around the country Outcome – Refurbishment, Demolition, Selling, Conversion. After revisiting the criteria, the outcome then changed to Refurbishment, Selling, Conversion and Demolition.	The colours of the output and input cells were differentiated as suggested by the participant to ensure functional usage during the validation.
PhD Student – Quantity Surveyor	When asked about the instinctiveness of the model, the participant states to the researcher that "*you are using it, I have not used it. I need to be fair as much as possible. So, because I have not used it*". Need for DMM – Yes, Outcome – Refurbishment, Conversion, Demolition and Selling	The participant commented on the adverse effect of not being able to use the model directly.

6.1.2 Pilot Study Results

The qualitative comments from the pilot participants were enlightening with regards to the overall format and delivery of the case study. There were a few minor comments on the model parse. These ranged from the inclusion of the pictorial view of the case study at the cover page, improvement on terminologies used and additional information within some sheets, population of the information page to include more information, and presentation of the decision-making page to be void of formulas and calculations. The researcher further amended the worksheets to remove the gridlines (Refer to Figure 6.1) and the headings to improve the worksheet to graphic interface (Figure 5.5).
The overall presentation was well received and commended. The navigation buttons within the model were used simultaneously with the lower tab buttons on the worksheet. The researcher explained that the navigation buttons are quite easy and better to use in accessing the other worksheets. The navigation buttons were used for viewing and ease of interpretation from the researcher.

There were suggestions on the removal of some of the worksheets such as the "Associated Guidance Worksheet" (Appendix 13) since the decision-making model (DMM) will be used by the senior management. One of the participants requested the change of the scale of relevance from 1-5 to 1-3 (that is highest, lowest, and moderate). However, to present better quality and robust data, the Likert scale 1-5 was retained (Revilla et al. 2013). Moreso, Ogunnusi et al. (2023) applied a Likert scale of 1

to 5. Hence the scale of reference 1-5 is retained. The outcome of the evaluation of the alternatives and criteria presented Refurbishment as the highest ranked alternatives by all the 7 participants in the pilot study (Table 6.2).

Table 6. 2 : Four alternatives ranking by the 7 academia during the pilot study.

Participants	1st	2nd	3rd	4th
PhD Student 1	Refurbishment	Conversion	Demolition	Selling
Research Fellow	Refurbishment	Conversion	Selling	Demolition
PhD Student 2	Refurbishment	Selling	Conversion	Demolition
Senior Lecturer 1	Refurbishment	Conversion	Selling	Demolition
Senior Lecturer 2	Refurbishment	Conversion	Demolition	Selling
PhD	Refurbishment	Selling	Conversion	Demolition
PhD Student 3	Refurbishment	Conversion	Demolition	Selling

One of the participants suggested that the worksheet for calculating the criteria weightage should be the last sheet in the model to avoid confusion for the participants.

Table 6.3 presents the results of the pilot study. These reveal the scores including minimum and maximum boundaries with the mean scores. The Standard Deviation has also been presented to provide an analysis of variance of the collective results. In general, positive feedback was received from the participants during the pilot study. The feedback also includes the total score rate of 4.30 with a relatively small Standard Deviation average of 0.83.

Table 6. 3 : Results of the pilot study

	EFFECTIVENESS FOR INTENDED USE	Min	Max	Mean	Median	Mode	SD
1	Within the Project Information section, there was sufficient information to enhance decision making process	2.00	5.00	4.14	5.00	5.00	1.21
2	The information provided on the project Information Section page is adequate.	1.00	5.00	4.14	5.00	5.00	1.46
3	The Map *and Guidance* page is valuable to the process	3.00	5.00	4.29	4.00	5.00	0.76
4	The Sustainability Initiatives page is beneficial in enabling the process of selecting the relevant attributes, criteria, and alternatives	3.00	5.00	4.00	4.00	4.00	0.82
5	The Associated Guidance page is useful for decision making	3.00	5.00	4.00	4.00	4.00	0.82
6	The Decision-Making Model page facilitate adequate comparisons to be made between the selected alternatives and the criteria.	3.00	5.00	4.29	4.00	5.00	0.76

7	The Decision-Making Model page enables the adequate performance rating to be applied to the most suitable options	4.00	5.00	4.57	5.00	5.00	0.53
8	The model is beneficial to the sustainable redevelopment of abandoned infrastructure in Nigeria	3.00	5.00	4.29	5.00	5.00	0.95
9	The model is valuable in supporting me with the selection of the preferred option	3.00	5.00	4.57	5.00	5.00	0.79
10	The varieties of topics including the criteria and alternatives discuss in the model is sufficient	2.00	5.00	4.00	4.00	4.00	1.00
11	The Model is valuable in ascertaining best value for money from the identified options	3.00	5.00	4.29	4.00	5.00	0.76
	The Effectiveness of the Platform (Zoom) and the tool Interface (Excel Spread Sheets)						
12	Is the tool visually suitable	3.00	5.00	4.14	4.00	5.00	0.90
13	Is the tool easy to navigate	3.00	5.00	4.57	5.00	5.00	0.79
14	Are the links instinctive and easy to use	3.00	5.00	4.29	4.00	4.00	0.76
15	Is the Drop-down menu entry appropriate	3.00	5.00	4.43	5.00	5.00	0.79
16	Is the text entry to the tool appropriate	4.00	5.00	4.71	5.00	5.00	0.49
	User Satisfaction						
17	Is the User Interface easy for usage	4.00	5.00	4.71	5.00	5.00	0.49
18	All the terms used in the model are clear and very easy to understand.	2.00	5.00	4.14	4.00	5.00	1.07
19	The results of the model appear to be logical and realistic	3.00	5.00	4.29	4.00	5.00	0.76
20	The structure of the tool pages are very simple to follow and logical	3.00	5.00	4.29	4.00	4.00	0.76
21	The tool is user -friendly and uncomplicated	3.00	5.00	4.14	4.00	4.00	0.69

6.2 Model demonstration

A constraint of the pilot study was that, rather than using construction participants, academics were used. This was justified as the pilot was not focused on data collection (from the "real" world) but on the continuity and format of the model presentation. Nevertheless, this fact also emphasised the cruciality of recognising and employing a credible and suitable sample population to partake within the Demonstration / main testing and validation exercise. There were two key characteristics that the researcher considered important for a credible and balanced procedure:

1. Appropriate selection of the physical building types
2. Appropriate selection of the expert participants.

With the abandoned infrastructure of different types littering the entire environment across Nigeria~~,~~ the research scope (for the validation) was narrowed to consider the Government public office buildings within Nigeria. The Federal Secretariat building was identified as the case study (see section

5.3.2). About 60% of the participants during the semi-structured interview (Chapter 4, Section 4.3) referred to the Federal Secretariat, Lagos Nigeria within the earlier discussion of abandonment.

It was imperative to consequently recognise and involve construction professionals from the design and construction-oriented disciplines.

The model development emanated from the knowledge gap identified during the semi-structured interview. The triangulation of the findings during the interview also revealed sustainable alternatives for the redevelopment of these buildings ranged from refurbishment, conversion, demolition, and selling. Thirteen (13) professionals were contacted to indicate interest in the demonstration and validation process. Twelve (12) accepted the invitation and eleven (11) were eventually interviewed due to availability issues.

The significant point to be noted in the design process of the testing phase was to design an online one-on-one workshop in a manner that duplicates the actual individual decision maker within a decision-making team. The model demonstration session was designed for individual professional participation. The timing and availability of the participants at a specified time virtually for a workshop/focus group was one of the constraints of this study. Hence, the model was individually presented to the participants with their feedback recorded. It is necessary to note that the model can be applied individually or collectively as a group. Table 6.4 indicates the built environment professionals that participated in the validation process.

Table 6. 4 : Demography of the participants

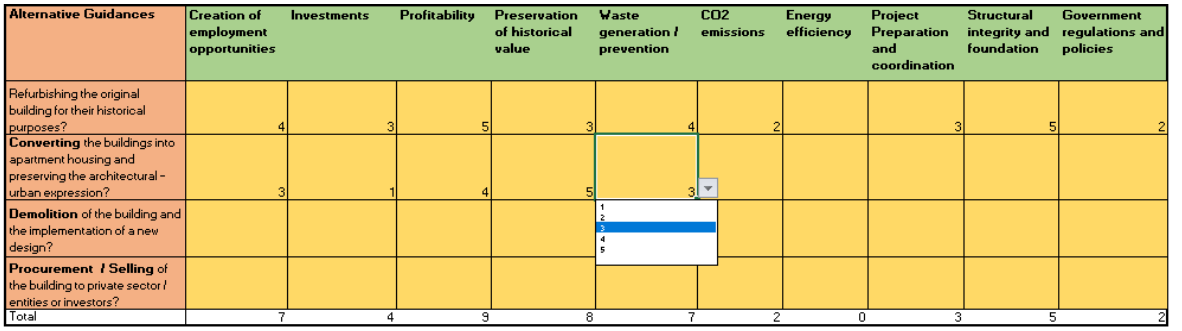
Participants	Description	Years of Experience
PM1	Project Manager	47
BU1	Builder	25
QS 1	Quantity Surveyor	20
BU 2	Builder	27
CE 1	Civil Engineer	30
ARC 1	Architect	30
PM 2	Project Manager	16
ARC 2	Architect	37
ARC 3	Architect	8
CON 1	Contractor	34
CM 1	Construction Manager	22

The feasibility of testing the model is fundamental as this was a planned part of the research design. The researcher did not send the model to the participants, rather, the researcher presented the model via zoom meeting (and completed the form with the information provided by the participant(s). The participants were debriefed/ informed that the testing and validation process of the model was to demonstrate how the model can be used in a decision-making scenario (on the case of the abandoned infrastructure). The researcher pointed out some salient points from the consent form that were relevant for the interview session, including the aim and the objective(s). Other information provided by the researcher comprised of the interview duration, flexibility for the interviewee to decline any question(s) and extension of time if necessary, at the volition of the interviewee. The researcher was also able to rephrase the question to conform to the participants understanding. All the participants individually confirmed their acceptance to participate in the recorded interview before commencing with the questioning.

When it was time for comparison of the criteria and the alternatives using the scale of relevance (Figure 5.8), the researcher requested the individual participant of their opinion, and they responded accordingly while the researcher noted the scale selected by the participants with the drop - down menu (as seen in Figure 6.2). The demonstration style of the model and the interaction between the researcher and the individual participants permitted for a fluid and natural discussion to take place during the session.

The scoring feedback was provided with some of the participants providing reasons for their scoring. This opens up the need for additional documentation for the model. For instance, requesting for clarity on the scoring of one of the participants created a reminder for the need to provide the User Guide (Appendix 13) as part of the documents for the participants.

Due to the nature of the demonstration design, the researcher was privy to the feedback and the scoring form without prejudices as all these were recorded sessions. This may be seen as a constraint to the research, however, for the intention of the data prerequisite, this depth of filtering is perceived as being absolutely accurate for these objectives.



Alternative Guidances	Creation of employment opportunities	Investments	Profitability	Preservation of historical value	Waste generation / prevention	CO2 emissions	Energy efficiency	Project Preparation and coordination	Structural integrity and foundation	Government regulations and policies
Refurbishing the original building for their historical purposes?	4	3	5	3	4	2		3	5	2
Converting the buildings into apartment housing and preserving the architectural – urban expression?	3	1	4	5	3					
Demolition of the building and the implementation of a new design?					1 2 3 4 5					
Procurement / Selling of the building to private sector / entities or investors?										
Total	7	4	9	8	7	2	0	3	5	2

Figure 6. 2: Form completion during DMM demonstration

The model is with the capacity to prioritise decisions as a benefit to the client and the decision makers at the outline proposal/decision making stage. The model is expected to assist the decision makers in the government, agencies, and industry professionals in the decision-making process. The case study provided a platform for discussion points on the model itself, and the individual participants were able to discuss the application of the model in the context of sustainability and other potential needs and projects. Table 6.5 presents the participants' views on the imperativeness of the DMM to sustainable redevelopment of abandoned infrastructure in Nigeria.

Table 6. 5 : Participants responses on the need for DMM

Participants Code	**Need for DMM - Is there a need for Decision Making Model for undertaking the sustainable redevelopment of abandoned infrastructure in Nigeria?**
PM 1	*Yes, there are*

BUI 1	*You know…. for you coming up with this, I believe, I 'm rest assured that a lot of people would want to leach more on this as an advantage to us in Nigeria to make decision out of data, you know, very important*
QS 1	*Yes, there is need*
BUI 1	*Yes, Yea,*
CE 1	*Very high need, yes*
ARC 1	*Very, very important. Very important…I am telling you that we need more…, when you see the sustainability factors, political, economic, so, there have to be further robust additional variables based on the various professional interest. You know, we are talking now as built industry professionals. So, if a lawyer wants to make a decision, you know his variables will be slightly more different. So, it's very important, but we need all the various professionals...*
PM 2	*Yes, there is a need. There is a need for decision making model because this model that you have developed now would help future property developers to know how to go about investing in property development in Nigeria*
ARC 2	*Yes, Yes, Yes, Yes. There is. But what I would suggest, is that, you know, you are managing human beings, and human beings are not managed mathematically. And so quantitative, depending solely on quantitative assessment may not be appropriate. We need to infuse some qualitative and survey objectives where people can make their own input freely instead of configuring every person to mathematics. You understand what I mean..... What I mean is that, in the analysis, as you summarise your... as you comment on this thing, your qualitative analysis will be very important so that you have a mixed approach to it.*
ARC 3	*You see, most of decision makers we have in Nigeria presently, I think they need guidance and one of those guidance are appropriate tool like your (the researcher) decision making model (DMM). If they have the tools, it will enable them to make accurate decisions, just by looking at the data that you have presented. So yes, I would… I agree to that… there is a need.*
CON 1	*Anything that will help us do something about those buildings, yes*
CM 1	*There is em, I think em, If this can be adopted, it is going to resolve a lot of issues we have around abandoned projects today. You know, issues of abandoned projects are government issues because most of the abandoned projects are government projects, and these projects needs legislation. At times, it needs a presidential approval before you can even carry out some of these selling, demolition, refurbishment, or conversions that we are looking at. Now, if this can be done, the government gives order, under a need assessment... they now commission some consultants to come and carry out, use this model to*

> *carry out these assessments, for project. You see, it is no more the government taken decision on their own, the model will take the decision for them, and once they approve it, It can now be implemented. That's the gap that we have today. Nobody is ready to 'bell the cat'. Because you as a civil servant, you don't have the power to take a decision that convert this building or sell these buildings or do these. So, these are the areas that we have.. this is the gap that I have seen. So, I think this will help.*

In summary, the participants expressed the need to make decisions from available data. The sustainability factors were also highlighted for consideration. The initiative of developing this model with embedded mathematical calculations to enhance robust decision making was also commended. ARC 3 eventually envisaged the model resulting to a tool to enable an "accurate" decision making.

6.3 Primary Validation Scoring

With ARC 3 comments on 'model resulting to a tool' in Table 6.3, and also Akande et al. (2021)'s recommendation, It can be confirmed that the MS Excel spread sheet actually represented the tool in which the model was presented as seen in Table 6.6.

Subsequent to the testing stage, Table 6.6 provides the collation of the cumulative results for all the participants. This reflects the method applied throughout the primary data collection exercises as examined in the methodology chapter.

Table 6. 6 : Validation scoring

	EFFECTIVENESS FOR INTENDED USE	Min	Max	Mean	SD	
1	Within the Project Information section, there was sufficient information to enhance decision making process	3	5	3.727273	0.786245	41
2	The information provided on the project Information Section page is adequate.	3	5	3.636364	0.80904	40
3	The Map *and Guidance* page is valuable to the process	3	5	4.363636	0.80904	48
4	The Sustainability Initiatives page is beneficial in enabling the process of selecting the relevant attributes, criteria and alternatives	3	5	4.454545	0.8202	49
5	The Associated Guidance page is useful for decision making	3	5	4.2	0.788811	42
6	The Decision-Making Model page facilitate adequate comparisons to be made between the selected alternatives and the criteria.	3	5	4.545455	0.687552	50

7	The Decision-Making Model page enables the adequate performance rating to be applied to the most suitable options	3	5	4.272727	0.786245	47
8	The model is beneficial to the sustainable redevelopment of abandoned infrastructure in Nigeria	3	5	4.363636	0.6742	48
9	The model is valuable in supporting me with the selection of the preferred option	3	5	4.272727	0.786245	47
10	The varieties of topics including the criteria and alternatives discuss in the model is sufficient	3	5	4.272727	0.786245	47
11	The Model is valuable in ascertaining best value for money from the identified options	3	5	4.272727	0.786245	47
	The Effectiveness of the Platform (Zoom) and the tool Interface (Excel Spread Sheets)					
12	Is the tool visually suitable	3	5	4.363636	0.80904	48
13	Is the tool easy to navigate	4	5	4.727273	0.467099	52
14	Are the links instinctive and easy to use	4	5	4.636364	0.504525	51
15	Is the Drop-down menu entry appropriate	3	5	4.545455	0.687552	50
16	Is the text entry to the tool appropriate	4	5	4.636364	0.504525	51
	User Satisfaction					
17	Is the User Interface easy for usage	3	5	4.5	0.707107	45
18	All the terms used in the tool are clear and very easy to understand.	3	5	4.454545	0.687552	49
19	The results of the model appear to be logical and realistic	4	5	4.727273	0.467099	52
20	The structure of the tool pages are very simple to follow and logical	4	5	4.6	0.516398	46
21	The tool is user -friendly and uncomplicated	4	5	4.6	0.516398	46

Table 6.6 provides the minimum and maximum results factors as 3 and 5 respectively. The mean (average) scores are indicated with analysis of variation illustrated with standard deviation scores on each question. A mean was calculated at 4.39. Equally, the average standard scoring was 0.69 which indicates a relatively high standard deviation relative to the mean as evident in the spread of data recorded from the survey after the overall demonstration. This denotes a high degree of unanimity from the respondents during the questioning session of the demonstration and also reflects the results of the pilot study.

Generally, the results imply a high positive response from the demonstration and validation. For instance, ease of navigation within the model (Refer row 13-15 of Table 6.6), usage and entry were rated high. it is necessary to point out the weakest indicated area was the inadequacy of the information section page. This was due to the limited information of the case study (Federal Secretariat) online.

This further indicates the benefit of the information page to the model and also reinforces the need to uncover sufficient in-depth information for the case study, especially in the context of the model's future development.

The outcome of the evaluation of the alternatives and criteria presented refurbishment as the highest ranked of the alternatives. According to the table 6.7, 4 ranked it as first, 3 ranked it as second, 2 ranked it as third and 2 ranked it as fourth.

Table 6. 7 : Alternatives ranking by the professionals during the validation.

Participants	1st	2nd	3rd	4th
PM 1	Refurbishment	Demolition	Conversion	Selling
BU 1	Refurbishment	Demolition	Selling	Conversion
QS 1	Demolition	Selling	Conversion	Refurbishment
BU 2	Selling	Conversion	Refurbishment	Demolition
CE 1	Refurbishment	Selling	Conversion	Demolition
ARC 1	Demolition	Refurbishment	Selling	Conversion
PM 2	Conversion	Refurbishment	Demolition	Selling
ARC 2	Conversion	Refurbishment	Selling	Demolition
ARC 3	Demolition	Conversion	Selling	Refurbishment
CON 1	Refurbishment	Selling	Demolition	Conversion
CM 1	Conversion	Demolition	Refurbishment	Selling

6.4 Chapter Summary

The model developed was tested and validated in this chapter. The testing was done as a pilot within the academic environment to ascertain the functionality of the model. This was then demonstrated to built - environment professionals for validation.

Scoring process with the aid of Likert scale 1-5 was adopted to ascertain the standard deviation and analysis within the results. This was applied to both the pilot study and the main study. The comments of the participants during the pilot study were considered in the model for the main study. Other observation during the demonstration were also presented within the chapter with the use of a real-life case study.

The result from the demonstration of the TOPMod DMM model presented high positive response. The next and the final chapter within the research present the discussion, conclusions, and recommendations for future research.

CHAPTER SEVEN: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

7.0 DISCUSSION

The aim of this research was to determine the causes of abandonment of infrastructure in Nigeria with a view of evaluating the impact of factors contributing to the causes of these abandonment. Furthermore, the study intends to identify possible remedies of sustainable development of abandoned infrastructure and recommend optimum applicable solution to the decision makers through the development of a Multi Criteria Decision Making (MCDM), the technique for order preference by similarity to an ideal solution (TOPSIS), model (TOPMod). The model should proffer the basis for a decision - making framework for the Nigerian government and built environment professionals when addressing infrastructure abandonment in Nigeria. As the previous chapter has demonstrated how the model was presented and validated to academics and professionals in the built environment (through the quantitative and qualitative data collection and analysis) informed the decision-making framework, this section presents detailed discussion of the framework efficiency and user satisfaction.

7.0.1 Decision-Making Model Efficiency

It was highlighted that human beings are faced with many decisions established on diverse options of alternatives and criteria in our everyday life. The decision-making was identified as an inevitable features of model selection. In essence, this implies that decision-making process must be carried out to obtain an appropriate decision-making approach. Having recognized decision-making tools, MCDM techniques were identified with the eventual selection of TOPSIS Technique. The MCDM TOPSIS Model (TOPMod) integrate the alternatives, criteria and attributes for evaluation and ranking of the most appropriate options. With the integration of the TOPMod into the MS Excel, the middle ground is to comprehend efficiency of the tool (components) in Nigeria during the decision-making process of abandonment of infrastructure with specific attention on public buildings.

The MS Excel had been adopted as a simple decision-making sheet in other countries such as United Kingdom, Lithuania, France, Germany, and Italy. The efficiency is necessary to understand the effective assessment of the public building. The navigation tools with the MS Excel sheets render the tool quite easy to apply in accessing other worksheets. The drop-down menu ensures user friendliness and unhindered evaluation of all the sustainability elements. Unlike, other MCDM Model such AHP that can be applicable for complex problems as noted by Balioti et al. (2018), Kabir and Hasin (2012) identified TOPSIS as simple and easy to use on a large-scale data. The TOPMod further support the identification of innovative tool for decision making. It is also considered when the need arises to evaluate on easier weighting method.

The weighted evaluation process can support the application of this model in other buildings and projects in other countries (Roy 2019). In essence, the application of this model in any other situation, country or project can only be possible with the adoption of criteria weight within the model. With different classification of the criteria weightage by Odu (2019) the weightage has overall outcome of the decision-making process. With the TOPMod evaluation for this abandoned Federal Secretariat, mean weight from Odu (2019) and Mohare's were utilise for comparison of each criteria against other.

7.0.2 Preventative approach to abandonment

In preventing this abandonment from continuous existence, Ariffin et al. (2018) suggests that mitigation plans are necessary. To address it further, Okereke (2016) identifies the plans as "strategies". The planning needs to be considered imperative at project inception as improper planning was mentioned as one of the causes of abandonment. For instance, more than 50% of the participants during the qualitative data collection (Semi -structured data collection) mentioned lack of adequate or proper planning as one of the reasons for abandonment. In fact, within this research, it was considered one of the fundamentals for ethical consideration. Interestingly, Akande et al. (2015), highlighted the need for the end of construction during the design phase. With global call for sustainability and net zero, the planning process which is also one of the phases of construction project as noted by Omotayo et al. (2018) should consider the sustainability and reduction plan policies in the Construction Playbook developed by the UK government.

7.0.3 Need and the accessibility of the model by the Users

To ensure the identification of possible solutions (with multiple solutions) to the decision makers in addressing the abandonment, it is necessary for the Users to interact and engage with model for the evaluation of the model component and select the most appropriate solution. This model was tested and validated by the built environment professionals with overall positive feedback. Although, it is envisaged that future development to improve further engagement with the model by the decision maker has been identified. For instance, the model can be accessible to the decision makers by direct transfer of files through email to the decision makers. Further development such as the accessibility through webpages. This could be a whole new area of research.

7.0.4 Political and Technological sustainability.

Not until the commencement of this research, the three sustainability pillars have always been, social, economic and environment. However, further literature reviewed with this study projected the need for these two pillars. Political and technological are both considered by Vizzarri (2020) and Pavlovskis (2017) respectively. Due to political ambitions, Hanachor (2012) identified that project that were probably political conceived are not meeting the needs of the community resulting to abandonment. Recurrent change in political power and government was also predominant as findings for this abandonment both from literature (Amade 2015) and primary data collection. Faulty assumption of political position with no intention of completing the projects commenced by preceding Government, politicized appoint of stakeholders, or who takes credits are some of the downsides of the political influences.

On the other hand, Vacchi et al. (2021) believed that different component of sustainability that enabled technology is missing. In view of this, use of innovative technology such as BIM, MCDM gBIM are being recommended by some Authors (Volk et al 2014). The suggestion was not limited to desk study as the need for technology – "home-grown technology" was also pointed at by some of the respondent during the primary data collection.

The objectives will be examined as well in addition to the model development within the study. A structured method is presented in this chapter to address the research questions and the objectives.

7.1 The objectives

The summary of each objective is highlighted below**:**

7.1.1 Research Objective One.

- To explore the sustainability of infrastructure in Nigeria in line with the UN sustainable development goals.

A desk study was conducted to explore the sustainability of infrastructure in Nigeria in line with UN sustainable development goals. The Federal government of Nigeria recognised the importance of the implementation of 17 sustainable development goals to their socio-economic development progress in 2017. However, with critical consideration of two of the SDGs comprising of Goals 9 (Industry Innovation and Infrastructure) and SDG 11 (Sustainable Cities and Communities), abandonment of infrastructure is being recorded as evidenced. This is in contrast to the expectations of sustainable cities and communities' delivery in the country. Nigerian governments were only particular about "investment". Accelerating investments in infrastructure is not the same as ensuring the sustainability of that infrastructure.

Further study found that the "aspiration" of sustainable development is not only about erecting new developments but also about developing abandoned environments. To ensure a long period of use of government assets, while also playing a major socio - economic role, there is a need for conformity of the infrastructure development to the TBL (social, economic and environment) of sustainability. Authors state that Nigerian public sectors are lagging in the global campaign for sustainability in infrastructure procurement. Sustainability is essential for the conservation of infrastructure resources to meet current needs and the needs in the future through environmental viability, cost effectiveness, social equitability, and resilience. For example, Shell, a multinational company has been urged by the local (Architects, academics, and climate activists) within Aberdeen, United Kingdom not to demolish the modernist headquarters due to fear of carbon emissions (Livingston 2023).

Literature reviews and the research findings indicate that the current approach to infrastructure development in Nigeria is not consistent with the UN sustainable development goals. The goals requirements for sustainable cities and communities are still far from being met.

This was also discussed during the interview, as some of the participants such as PM1, CE1, BU1, ARC 2, ARC 3 presented their views and understanding on sustainable development in line with infrastructure from economic, environmental, and social perspective.

This objective was beneficial to understanding the context of sustainable development in line with abandonment in Nigeria.

7.1.2 Research Objective Two.

-To determine the causes of abandonment of infrastructure in Nigeria.

With the evaluation of the secondary data, the literature review has presented various definitions and a discussion of the concept – infrastructure abandonment and causes. The findings from literature includes defect design, changes in government, cost overrun, inefficient procurements, deficiency in technological capability, ineffective payment structure, corruption and politics, inflation, information

and communication gap, non-functional and inconsistent government policies amongst other. A major finding from the literature review was attention to effective procurement process, adoption of innovative management tools and the need for the government to consider the social, environmental, and economic impact of redeveloping abandoned infrastructure in Nigeria. Within the primary research, ineffective procurement process ranked highest as the cause of abandonment. Most of these findings were also confirmed through primary data collection when questions such as awareness involvement were presented to the respondents. With the evaluation of the secondary data, the literature review has presented various definition and discussions of the concepts – abandonment, infrastructure. The further findings based on these objectives was that there is no country without some examples of abandoned infrastructures, but Nigeria's situation requires a more rigorous attention.

7.1.3 Research Objective Three.

-To evaluate the impact of factors contributing to the causes of these abandonment.

These abandoned structures are generating health and social problems while marring the environmental aesthetics of the country as presented from the literature review. The literature review further evaluated the impact of abandonment as being waste of material and financial resources, threat to the environment, spread of disease, housing shortage, depleted government reserve, negative impact on real estate value, noise and pollution, reduction in accruable revenue to the government, decrease and decline in employment prospects, hide-out and accommodation for hoodlums, low quality of living standards, Loss of Lives, negative impacts, loss of strength of structural components, abode for perilous animals such as insects and snakes, socio - economic impact, rise in unemployment, population marginalization.

The impact of factors was also evaluated in detail during the primary data collection phase. These four sets of multiple questions of impact of the abandonment as; (i) non-eco - friendly, (ii) uneconomical, (iii) constitute social menace and (iv) waste of useful resources were also responded to effectively by the participants. Majority of the participants during the primary data collection selected "All of the above" as their response. "Waste of useful resources" was second on the list while "constitute social menace" and "non-eco-friendly" was ranked lowest.

These support some of the findings in objective one that Nigeria has consistently performed below expectation when compared with her counterpart. Hence Nigeria's situation requires further attention.

7.1.4 Research Objective Four.

-To identify possible remedies of sustainable development of abandoned infrastructure

From literature reviews and the primary research, the following remedies were identified to include change in procurement methods, refurbishment, innovative management tools deployment and designing with deconstructability. All these suggestions did not give any defined consideration for sustainability.

For remedies with sustainability in mind, a set of alternatives and criteria in line with five sustainability attributes of social, economic, environmental, political, and technical attributes (SEEPT) must be considered. Examples of sustainable alternative remedies from the literature include refurbishment, conversion, demolition and selling. The sustainability criteria to be considered among others, waste generation, regulations and policies, investment, and carbon dioxide emission.

Further clarification through the semi- structured interview presented various possible solutions from the participants. There were indications of engaging in decision makings from the participants. However, none of them considered it as a process or provision of a tool to attain the best solution.

For governments and construction professionals to effectively consider all the sustainability attributes, alternatives, and criteria in addressing abandonment of infrastructure, it becomes imperative that they will need the help of tools or technologies for an interactive engagement and systematic decision making.

Conclusively, to be able to come to solutions that recognizes the sustainability attributes and their criteria in addressing abandoned infrastructure, innovative technologies must be deployed that enables decision makers to find sustainable solutions to the structures.

7.1.5 Research Objective Five

-To explore techniques and / or tools that could address infrastructure abandonment

Having identified the need for innovative tools in the last objective four, the study progressed to exploring for techniques or tools that could help address infrastructure abandonment. Different tools were suggested from literature review and the surveys carried out. Notable tools mentioned include SWOT analysis, PARETO analysis, Decision Matrix, Ratio analysis and BIM.

One of the tools is Decision Matrix, the multi criteria decision making (MCDM) tool was found to be more appropriate given that it addresses the multiple dimensions of attributes and criteria requirements for sustainability. Other tools considered were found to either time consuming (SWOT) or largely for the design stage of infrastructure. TOPSIS, one of the tools of MCDM was considered as a workable option as it addresses a large sampling population compared to the other MCDM tools.

The MCDM – TOPSIS provides a tool that enables decision makers to systematically consider all the criteria and constraints for a sustainable development in coming to a decision on abandoned infrastructure.

The tool was applied to the case study and with the help of key professionals in the built environment and allied industries, the tools identified refurbishment as the sustainable solution to abandoned case study – Federal secretariat. Conversion, selling, and demolition ranked 2nd, 3rd and 4th respectively in the order of solution to address the case study.

The researcher has also presented the tool to decision makers in a user friendly and interactive way as a GUI in Microsoft Excel, removing the difficulties of working with mathematical expressions. Decision making model simplifies activities and processes by providing useful steps and guides to the policy makers during the decision-making process. The TOPSIS Model (TOPMod) was developed and presented with this thesis.

7.1.6 Research Objectives Six

-To design, test and validate an identified innovative tool (including level of knowledge relevant to the factors covered by the tool) with academia and built environment professionals.

A decision-making model TOPSIS Model (TOPMod) was developed through the primary data collection, and then presented to decision makers in the built environment for testing and validation.

The validation was in two stages of pilot and main. The pilot stage was to verify the efficacy and the functionality of the model (SEEPT sustainability, the alternatives, and the criteria). After the modification of the model. The built environment participants were invited with consent form signed for the demonstration. The same real-life case study that was adopted from the objective four was also presented to demonstrate the effectiveness of the model. In demonstrating the model, the

researcher works through the model with the selected experts (11 professionals) in a methodological approach.

The intention of the demonstration was also to test the mathematical functionality of the framework. With calculations required, (within the framework), and user friendliness and flexibility deemed essential, MS Excel was identified as an appropriate tool for the model. The tool was expected to be visually simple and easy to use with the aid of Graphical User Interface (GUI) and the drop-down menu. Despite, the operation of the tool by the researcher, the participants were able to interact with the model virtually.

At the end of the demonstration, the experts presented scored feedback with the use of a Likert Scale for the validation process of the model. The qualitative comments on the need for the decision-making model was also obtained from the academics and the professionals to further support the validation process. For instance, the model evidenced accurate decision making as posited during the discussion. Additionally, the information page of the model was not adequate to some of the participants. This was accepted as constructive criticism, and the researcher's defence was on the dearth of information on the case study adopted.

All in all, the result evidenced a high positive response from the demonstration and the validation of the model.

7.2 Contribution to Knowledge

Shaheen (2021) defined originality as unique and new knowledge added to the body of knowledge of a field and unearthed through study, observation, or experiment to provide a solution to the real-life problem.

With regards to methodology, this research contributes to knowledge in the following areas:

- The research identified causes and impact of abandoned infrastructure in Nigeria both quantitatively and qualitatively. Identifying it qualitatively was a stride ahead of previous literature such as Woka and Miebaka (2014); Ezenekwe and Uzonwanne (2017) and Nnamseh and Akpan (2021) that have only identified the causes quantitatively.

- The study evaluated the possible remedies obtained from primary data collection with the SPSS Pearson correlation. The level of significance obtained from the analysis presented the consideration of other possible variables such as the consideration of the 5Rs as multiple concepts to address the waste management of abandoned infrastructure in addition to innovative technology.

- With sustainability in mind, there was a need to identify the ideal solution to address the abandonment. Hence, additional quantitative data was collected with the consideration of social, economic, environmental, political, and technical (SEEPT) attributes (Section 2.2.1.3 and Section 2.2.1.4). Using a real-life case study, the study adopted the technique for order preference by similarity to an ideal solution (TOPSIS), one of the MCDM techniques to identify the optimum ideal solution out of the four alternatives of refurbishment, conversion, demolition, and selling.

- The researcher considered the flexibility of the application of the TOPSIS technique by the decision makers without the users engaging in the rigour of mathematical calculation during the decision making. Hence, a mathematical model was developed, demonstrated, and validated within this study as a framework for application within the decision-making process by the decision makers to address abandoned infrastructure in Nigeria.

7.3 Contribution to practice

The framework developed from this research will be helpful to inform future practice across the decision makers within the government and the built environment professionals. This is due to the model developed as a framework by this research providing a pathway for decision making when addressing abandoned infrastructure in Nigeria.

7.4 Limitations of the research

Some limitations were encountered in this research despite the achievement of the aims and objectives. These limitations are hereby discussed below with recommendation for further studies.

The initial limitation can be considered as the scope of the study. From literature review process, it was evident that the structure and categories of infrastructure provided enormous resources which may not be practicable for study in this context. Even with consideration of public buildings, there are public schools, hospitals, and housing which may extend the focus of this research. With time and the resource limitation of this research, it was hence appropriate to focus on redevelopment of abandoned public office building.

The limitations encountered from data collection were initially the impediment encountered during the COVID pandemic in 2020. This changes the mixed method sequential process from exploratory to explanatory. Hence, semi-structured interview, an instrument of a qualitative data collection scheduled as the first data collection was replaced with questionnaire survey to obtain the initial participants view on the study. Moreso, there were ranges of possible suggestions and solution provided through literature reviews and participants responses at different stages of data collection. However, the research focus on the decision-making process to identify the best possible solution out of solutions. This includes the involvement of allied professionals at the data collection phase of the TOPSIS analytical method and the built environment professionals, only, for the demonstration of the decision-making model.

Lastly, the limitation for the model was the timing and availability of the individual professionals for the demonstration and validation. The participants were in different locations of the country, hence, the possibility of having the demonstration for a joint decision making was a challenge. Therefore, the demonstration process was performed to individual participants via zoom.

7.5 Conclusions and Recommendations for Future Research

The conclusions and the recommendations are hereby presented within this section.

This research establishes the suitability of TOPSIS technique for addressing abandonment of buildings. The sustainability of infrastructure in line with UN sustainable development goals was reviewed along with the causes.

Literature review of the causes of this abandonment highlighted effective procurement process, recurrent changes in government and political power, defective design, gap in communication, payment delays, inflation amongst others as causes of abandonment. This study identified possible solution through literature review and primary data collection. The research also identified that despite different solutions provided from different studies, there was no sustainability consideration of social, economic, environmental, political and technical attributes in trends of the solution provided. Further consideration within this study is the development of decision-making model to provide flexibility in the decision-making process. Hence, adopting this decision-making framework to address the abandonment issues within the government will portray the adherence to UN sustainable development goals.

Moreso, the sustainable solution to these abandonment through the identification of alternatives and criteria in the decision will enhance the robust evaluation during the decision-making process. This evaluation will definitely provide avenue for further action(s) or sub-action(s).

Lastly, the consideration of 5Rs concepts, which include rethinking, reducing, reuse, refurbishing and regulation as an alternative for waste management will enhance the resuscitation of these abandoned structures in Nigeria due. Sustainable development is not only about developing new infrastructure but also redeveloping abandoned infrastructure. The Federal Government has to explore this concept by rethinking how best these structures can be used, reducing the development of excess infrastructure, salvaging projects by reusing and refurbishing them where necessary and finally adhering to established regulations to avoid future abandonment. The overall framework of this study will enable the decision-making process in Nigeria to align with the sustainable development goals.

7.7 Personal Reflection

Reflecting on this research, the researcher considers the infrastructure abandonment as a problem that demands holistic solutions. Multiple solutions exist, hence the need to validate a model that will enhance the identification of optimum solution during the decision-making process. Furthermore, PhD study demands an open mindedness from a researcher for effectiveness. Sometimes, research outcomes can counter the initial beliefs of the researcher. The researcher must be open to the new findings irrespective of the initial assumptions

Lastly, the PhD journey is completely self-transformative. The process as viewed by the researcher is full of challenges, demanding hard work, positive mind-set, self- motivation, commitment, courage, intelligence, perseverance, and strength for accomplishment. I am so glad for the success.

7.8 Chapter Summary

This chapter which also includes the conclusions and the recommendations for future research discussed the arguments that informed this study. Through literature review, the argument was presented that a decision-making model is necessary in the selection of the optimum solution in the array of solutions.

Additionally, the aim and six objectives identified within this research were also highlighted for affirmation. The research question was reviewed for justification. For originality, this chapter evaluated the contribution to knowledge and practice identified from this study. The research limitations out of which result to recommendation for future studies were also examined.

Reflecting on this research, the researcher considers the abandoned infrastructure in Nigeria as a problem that requires attention. Hence, this necessitates the development of the DMM to fill in the gap of the decision-making process in addressing the abandonment.

Finally, this study has really been insightful and transforming for the researcher. Despite the challenges and limitations experienced during the study, the researcher is quite grateful for the experience of completing the study.

8.0 REFERENCES

ABDUL, E. O., RAIMI, K. O. AND IBISOLA, A. S. (2018) 'Effects of Abandoned Urban Infrastructure on Environmental Development in Ogun State', *Geomatics and Environmental Engineering*, 12(3), p. 5. doi: 10.7494/geom.2018.12.3.5.

ABOULNAGA, M. (2014) 'Sustainable Building for a Green and an Efficient Built Environment: New and Existing Case Studies in Dubai', Sustainability, Energy and Architecture, Ch. 6. ELSEVEIR Inc, pp:131 - 170.

ACAI, J. AND AMADI-ECHENDU, J. (2018) 'Pavement infrastructure sustainability assessment: A systematic review', *PICMET 2018 - Portland International Conference on Management of Engineering and Technology: Managing Technological Entrepreneurship: The Engine for Economic Growth, Proceedings*. doi: 10.23919/PICMET.2018.8481788.

ADAM, W.C (2015) 'Conducting semi-structured interviews', Chapter 19, Handbook of practical program evaluation, Fourth Edition, Jossey-Bass, A Wiley Imprint.

ADE PURNA NUGRAHA (2015) 'Analyzing patterns of classroom interaction Universitas Pendidikan Indonesia | repository.upi.edu | perpustakaan.upi.edu'.

ADETOLA, A., GOULDING, J. AND LIYANAGE, C. (2011) 'Collaborative engagement approaches for delivering sustainable infrastructure projects in the AEC sector', *International Journal of Construction Supply Chain Management*, 1(1), pp. 1–24. doi: 10.14424/ijcscm101011-01-24.

ADEYEMI, A. MARTIN, D. AND KASIM, R. ADEYEMI, A.I.(2017a) 'Facilities improvement for sustainability of existing public office buildings in Nigeria', *ATBU Journal of Environmental Technology*, 10(1), pp. 12–34.

ADEYEMI, A., MARTIN, D. AND KASIM, R. (2017b) 'Improvement of Existing Public Office Buildings in Nigeria from Users' Perspective Using Lean Thinking–A Pictorial View', *International Journal of …*, (June). Available at: https://iranjournals.nlai.ir/handle/123456789/342636%0Ahttps://iranjournals.nlai.ir/bitstream/handle/123456789/342636/5B95668C5BD8F6A5DF6161CC54FDC35D.pdf?sequence=-1.

ADIL, A. (2019) 'Analytical Study of the Causes of Abandoned Construction Projects', (December). doi: 10.28991/cej-2019-03091426.

AGBO, I.S. OGAI, N.A. (2013) ' The Need For Introducing Decision Support System (DSS) In Nigerian Universities Management And Administration', Information and Knowledge Management, 3(10), [online] Available from: https://core.ac.uk/download/pdf/234671499.pdf

AHMAD, NAJID; LUQMAN' MUHAMMAD AND HAYAT, M. F. (2012) 'Importance of Investment for economic growth: Evidence from Pakistan', *Interdisciplinary Journal Of Contemporary Research In Business*, 4(4), pp. 680–685.

AHMAD, E. DOWLING, D. CHAN, D. COLENBRANDER, S. GODFREY, N. (2019) 'Scaling up investment for sustainable urban infrastructure : A guide to national and subnational reform', (April 2020), pp. 1–46. Available at: http://newclimateeconomy.net/content/cities-working-papers.

AHMAD, T. AND THAHEEM, M. J. (2018) 'Economic sustainability assessment of residential buildings: A dedicated assessment framework and implications for BIM', *Sustainable Cities and Society*, 38(October 2017), pp. 476–491. doi: 10.1016/j.scs.2018.01.035.

AHMAD, U.A. RAMDANI, I. ISHAM, F.M. SEPTIAWAN, R.R. SETIADY, R.R.D. RUSDINAR, A. DINIMAHARAWATI,A. PRATAMA, Y.D. SOFYAN, F. ALAM, R.S. (2022) ' Development of mobile billing application system for PAMDES water meter data logging', JURNAL INFOTEL, 14(3), [online] Available from: DOI https://doi.org/10.20895/infotel.v14i3.779

AHMED, M.D. SUNDARAM, D. (2012) 'Sustainability modelling and reporting: From roadmap to implementation', Decision Support Systems, ELSEVIER, 53 (2012) pp. 611-624

AIMINHIEFE, M. I. (2022) 'Environmental Effects of Abandoned Building Projects in Edo State, Nigeria', *Official Publication of Direct Research Journal of Public Health and Environmental Technology*, 7(5), pp. 68–74. Available at: https://doi.org/10.26765/DRJPHET073519486.

AKANDE, **I.** SOWEMIMO, D. OYEDELE, O. ABASS, A**.** (2021) 'Potentials and Viabilities of Abandoned Public Buildings in Nigeria', *International Journal of Innovative Research and Development*, 10(5). doi: 10.24940/ijird/2021/v10/i5/may21031.

AKBARI, M. KHODAYARI, M. DANESH, M. DAVARI, A. PADASH, H.(2020) 'A bibliometric study of sustainable technology research', *Cogent Business and Management*, 7(1). doi: 10.1080/23311975.2020.1751906.

AKINADE, O. O. OYEDELE, L.K. BILAL, M. AJAYI, S.A. OWOLABI, H.A. ALAKA, H.A. BELLO, S.A. (2015) 'Waste minimisation through deconstruction: A BIM based Deconstructability Assessment Score (BIM-DAS)', *Resources, Conservation and Recycling*. Elsevier B.V., 105, pp. 167–176. doi: 10.1016/j.resconrec.2015.10.018.

AKOGUN, T. (2014) 'Causes and Effects of Construction Projects Abandonment in Ilorin Metropolis , Nigeria', *Scientific Research and Impact*, 3(4), pp. 65–74. Available at: http://jetems.scholarlinkresearch.com/articles/Abandonment of Construction Projects in Nigeria.pdf.

ALAO, O. O. JAGBORO, G. OPAWOLE, A. KADIRI, D. (2019) *Assessment of resuscitation strategies of abandoned projects: A case study of public tertiary education institutions' buildings in Osun State, Nigeria*, *Acta Structilia*. doi: 10.18820/24150487/as26i1.7.

ALAO, O. O. AND JAGBORO, G. O. (2017) 'Assessment of causative factors for project abandonment in Nigerian public tertiary educational institutions', *International Journal of Building Pathology and Adaptation*, 35(1), pp. 41–62. doi: 10.1108/IJBPA-07-2016-0016.

ALGHAMDI, H.A, LI, L. (2013) 'Adapting design-based research as a research methodology in educational settings', *International Journal of Education and Research*, 1(10), pp. 1–12.

ALI, A. (2021) 'Quantitative research tools', *IARS' International Research Journal*, 1(May), pp. 1–10. doi: 10.13140/RG.2.2.30033.25442.

ALI, K. A., AHMAD, M. I. AND YUSUP, Y. (2020) 'Issues, impacts, and mitigations of carbon dioxide emissions in the building sector', *Sustainability (Switzerland)*, 12(18). doi: 10.3390/SU12187427.

AL-NABAHANI, K. FORRESTER, I. SABBARTON, R. WISEMAN, A. WILLIAMS, G. REES, M, (2023) 'Lessons learned: competition in public procurement', Cabinet office, National Audit Office (NAO), Report by the Comptroller and Auditor General, pp 1-54, [online], Available from: https://www.nao.org.uk/wp-content/uploads/2023/07/lessons-learned-competition-in-public-procurement.pdf

ALIREZA, A. F. F**.** RASHIDI, T.H. AKBARNEZHAD, A. WALLER, S.T. (2017) 'BIM-enabled sustainability assessment of material supply decisions', *Engineering, Construction and Architectural Management*, 24(4), pp. 668–695. doi: 10.1108/ECAM-12-2015-0193.

ALLEGRETTTI, A. (2022) 'Plans to sell E1.5bn of UK government offices based on 'fantasy', say critics', Civil Service, Free Daily Newsletter, [online], Available from: Plans to sell £1.5bn of UK government offices based on 'fantasy', say critics.pdf

ALLEMANG, B., SITTER, K. AND DIMITROPOULOS, G. (2022) 'Pragmatism as a paradigm for patient-oriented research', *Health Expectations*, 25(1), pp. 38–47. doi: 10.1111/hex.13384.

ALLOU, S. COHEN, M. COOK, M. DRAKE, J. HOHMANN R.P. LEITMANN, J. LINDFIELD, M. SIDDIQUE, O. SIMPSON, J. ROBERTS, B.H. TJANDRADEWI, B. SHORT, C. (2021) 'Secondary Cities Post COVID-19 - Final Web: Achieving Urban Sustainable and Regenerative Development in Emerging Economies,' *Editors : Brian H Roberts and Joshua Drake*. doi: 10.1007/s11524-020-00438-6.CITATION.

'ALLUVIUM - DESIGNING BUILDINGS WIKI' (2023**)**. Available at:

https://www.designingbuildings.co.uk/wiki/Alluvium.

ALMEIDA, F. (2018) 'Strategies to perform a mixed methods study', (December). doi: 10.5281/zenodo.1406214.

ALNUAIMI, B. K. AND KHAN, M. (2019) 'Public-sector green procurement in the United Arab Emirates: Innovation capability and commitment to change', *Journal of Cleaner Production*, 233, pp. 482–489. doi: 10.1016/j.jclepro.2019.06.090.

AL-SAADI, H. (2014) ' Demystifying Ontology and Epistemology in research methods', University of Sheffield.

ALSHAMRANI, O., ALSHIBANI, A. AND ALOGAILI, M. (2018) 'Analytic hierarchy process & multi attribute utility theory based approach for the selection of lighting systems in residential buildings: A case study', *Buildings*, 8(6). doi: 10.3390/buildings8060073.

ALTUN, D. (2019) 'Preschoolers ' Emergent Motivations to Learn Reading : A Grounded Theory Study', *Early Childhood Education Journal*, 47(4), pp. 427–443. doi: 10.1007/s10643-019-00939-3.

ALUKO, O. (2023) ' 15 FG projects abandoned in 12 states, says Report', Punch Nigeria Limited. [online] Available from: https://punchng.com/15-fg-projects-abandoned-in-12-states-says-report/

ALDAWOD, A.DAY, J. (2017) ' A Critical Reflection upon the Postmodernist Philosophical Positions and Issues Relevant to Entrepreneurship Research, Original Citation, In: BAM 2017, 5-7,September 2017, University of Warwick, UK.

AMADE, B. UBANI, E.C. AMAESHI, U.F. OKOROCHA, K.A. (2015) 'Factors for Containing Failure and Abandonment of Public Sector Construction Projects in Nigeria', *Journal of Building Performance*, 6(1), pp. 63–76.

AMADEO, K. (2019) 'IMF, its objectives, structure, functions, members, role, history', [online] United State of America: The Balance. Available from: https://www.thebalance.com/what-is-the-imf-its-role-and-functions-3306115

AMADI, A. (2019) 'A cross-sectional snapshot of the insider view of highway infrastructure delivery in the developing world', *International Journal of Construction Management*, 19(6), pp. 472–491. doi: 10.1080/15623599.2018.1452097.

AMIRIL, A**.** NAWAWI, A.H. TAKIM, R. LATIF, S.N.F. AB. (2014) **'**Transportation Infrastructure Project Sustainability Factors and Performance', *Procedia - Social and Behavioral Sciences*, 153, pp. 90–98. doi: 10.1016/j.sbspro.2014.10.044.

AMRITASERVE (2019) 'EcoFriendly Infrastructure'.

ANASTASIU, L. (2018) 'The Decision-Making Process in Construction Project Management By Using the Electre I Method', *International Journal of Research Science & Management*, 5(2), pp. 1–14. doi: 10.5281/zenodo.1168806.

ANDERSON, S.HAMILTON, K. 2019) 'Don't write off abandoned buildings – they can be an important resource for the community', The Conversation Trust (UK) Limited, [online] Available from : https://theconversation.com/dont-write-off-abandoned-buildings-they-can-be-an-important-resource-for-the-community-116390#:~:text=Neglected%20and%20unused%20buildings%20are,enrich%20the%20lives%20of%20many.

ANDERSON, M.P. WOESSNER, W.W. AND HUNT, R.J. (2015) 'Applied groundwater modeling: simulation of flow and advective transport', Academic press.

ANNELIN, A. AND BOSTRÖM, G. O. (2022) 'An assessment of key sustainability competencies: a review of scales and propositions for validation', *International Journal of Sustainability in Higher Education*,

24(9), pp. 53–69. doi: 10.1108/IJSHE-05-2022-0166.

ANOMALY, J. (2015) 'Public goods and government action', *Politics, Philosophy and Economics*, 14(2), pp. 109–128. doi: 10.1177/1470594X13505414.

ANTUCHEVICIENE, J., ZAVADSKAS, E. K. AND ZAKAREVICIUS, A. (2012) 'Ranking redevelopment decisions of derelict buildings and analysis of ranking results', *Economic Computation and Economic Cybernetics Studies and Research*, 6(January).

ARASZKIEWICZ, K. (2016) 'Green Bim Concept- Scandina Vian', *Construction Innovation*, LXII(2), pp. 134–150. doi: 10.1108/CI-01-2014-0002.

ARI, I. AND KOC, M. (2018) 'Sustainable financing for sustainable development: Understanding the interrelations between public investment and sovereign debt', *Sustainability (Switzerland)*, 10(11). doi: 10.3390/su10113901.

ARIFFIN, N. F. JAAFAR , M.F.MD. ALI, M.I. RAMLI, N.I. MUTHUSAMY, K. LIM, N.H.A.S. (2018) 'Investigation on factors that contribute to the abandonment of building in construction industry in Malaysia', *E3S Web of Conferences*, 34(June 2015). doi: 10.1051/e3sconf/20183401025.

AROWOSAFE, O. ODUYEMI, O. CERANIC, B. DEAN, A. (2018) 'Sustainable infrastructure delivery in Nigeria: implementation of the analytic network process for contractor selection', *Sustainable Buildings*, 3, p. 5. doi: 10.1051/sbuild/2018003.

ARULDOSS, M., LAKSHMI, T. M. AND VENKATESAN, V. P. (2013) 'A Survey on Fuzzy Mcdm Methods and Its Applications', *American Journal of Information Systems*, 1(1), pp. 31–43. doi: 10.12691/ajis-1-1-5.

ARUP (2015) 'Cities Alive, Rethinking green infrastructure'.Online. Cities_Alive_booklet (1).pdf

ASIEDU, R.O. AND ADAKU, E. (2019) 'Cost overruns of public sector construction projects: a developing country perspective', International Journal of Managing Projects in Business, Emerald Publishing Limited, 13 (1), pp: 66 -84, DOI : DOI 10.1108/IJMPB-09-2018-0177.

ASLAN, M.C. AND KISACIK, H. (2017) 'Kurumsal Sürdürülebilirlik Çözümü: Üç Boyutlu Muhasebe', Muhasebe ve Finansman Dergisi, (Temmuz 2017 (Özel Sayı)), pp. 18–34. doi: 10.25095/mufad.402214.

ASHFORD, M. ABRAHAM, A. POOLTON, J. (2020) ' A Communal Language for Decision Making in Team Invasion Sports', Human Kinetics, pp. 1-8, DOI: https://doi.org/10.1123/iscj.2019-0062

ASVOLL, H. (2014) ' Abduction, deduction and induction: can these concepts be used for an understanding of methodological processes in interpretative case studies?' International Journal of Qualitative Studies in Education, Routledge, Taylor and Francis Group, pp.289-307, https://doi.org/10.1080/09518398.2012.759296

ATAMEWAN, E. E. (2020) 'Abandonment of Housing Projects in Nigeria: Appraisal of the Environmental and Socio-Economic Implications', *European Journal of Environment and Earth Sciences*, 1(4), pp. 1–6. doi: 10.24018/ejgeo.2020.1.4.29.

ATANDA, J. O. AND OLUKOYA, O. A. P. (2019) 'Green building standards: Opportunities for Nigeria', *Journal of Cleaner Production*, 227, pp. 366–377. doi:, E. 10.1016/j.jclepro.2019.04.189.

ATIF, A. RICHARDS, D. BILGIN, A. (2013) 'A Student Retention Model: Empirical, Theoretical and Pragmatic Considerations', AIS Electronic Library, (AISel), Australian ACIS, Proceedings. 141.

https://aisel.aisnet.org/acis2013/141

ATKINS, G**.** WAJZER, C. HOGARTH, R. DAVIES, N. NORRIS, E. (2017) 'What's wrong with infrastructure decision making? Conclusions from six UK case studies', *Institute for Government*, p. 46. Available at: www.instituteforgovernment.org.uk/%0Awww.instituteforgovernment.org.uk/ infrastructure.

ATOYEBI, O. (2021) 'Society of Engineers: There are 56,000 abandoned government projects across

Nigeria', The Cable, [online], Available from: Society of engineers: There are 56,000 abandoned government projects across Nigeria (thecable.ng)

AYEYEMI, D. (2021) 'Fresh Concerns Over Abandoned FG ' s Properties In Lagos', [online] Available from : https://tribuneonlineng.com/fresh-concerns-over-abandoned-fgs-properties-in-lagos/

AYEYEMI, D. (2022) 'Federal Secretariat Ikoyi: Stalled without prospects', [online] Available from: https://tribuneonlineng.com/federal-secretariat-ikoyi-stalled-without-prospects/

AZAD, K. (2023) 'How to analyse data using the average', [online] Available from: https://betterexplained.com/articles/how-to-analyze-data-using-the-average/

AZHAR, S. CARLTON, W. A.OLSEN, D. AHMAD, I. (2011) 'Building information modeling for sustainable design and LEED (R) rating analysis', Automation in Construction, 20(2), 217–224. https://doi.org/10.1016/j.autcon.2010.09.019

AZIZ, N. F., SOROOSHIAN, S. AND MAHMUD, F. (2016) 'MCDM-AHP method in decision makings', ARPN Journal of Engineering and Applied Sciences, 11(11), pp. 7217–7220.

BALARAS, C. A. AND DASCALAKI, E. G. (2019) *Energy efficiency in building renovation*, *Handbook of Energy Efficiency in Buildings: A Life Cycle Approach*. doi: 10.1016/B978-0-12-812817-6.00042-5.

BALIOTI, V., TZIMOPOULOS, C. AND EVANGELIDES, C. (2018) 'Multi-Criteria Decision Making Using TOPSIS Method Under Fuzzy Environment. Application in Spillway Selection', *Proceedings*, 2(11), p. 637. doi: 10.3390/proceedings2110637.

BALOGUN, A. (2016) 'Infrastructure Development in Nigeria: Better late than never', *Pwc Advisory outlook*, p. 6. Available at: www.pwc.com/ng.

BARTHE-DELANOË, A. M., NÉGNY, S. AND LE LANN, J. M. (2018) *Process Innovation through bio-inspired design*, *Computer Aided Chemical Engineering*. Elsevier Masson SAS. doi: 10.1016/B978-0-444-64235-6.50138-8.

BASKARADA, S. (2014) 'Qualitative Case Study Guidelines', 19(40), pp. 1–18.

BEHFAR, K. AND OKHUYSEN, G.O. (2023) ' Perspective—Discovery Within Validation Logic: Deliberately Surfacing, Complementing, and Substituting Abductive Reasoning in Hypothetico-Deductive Inquiry', Organization Science, 29(2), [online], Available from: https://doi.org/10.1287/orsc.2017.1193

BENSON, E. A. (2022) 'These are the 10 most developed countries in Africa based on UN's Human Development Index.pdf'.

BERMAN, J. (2016) 'Understanding your data 4'. doi: 10.1016/B978-0-12-803781-2.00004-7.

BERTONE, M. P. JACOBS, E. TOONEN, J. AKWATAGHIBE, N. WITTER, S. (2018) 'Performance-based financing in three humanitarian settings: Principles and pragmatism', *Conflict and Health*, 12(1), pp. 1–15. doi: 10.1186/s13031-018-0166-9.

BERTONI, M. (2019) 'Multi-criteria decision making for sustainability and value assessment in early PSS design', *Sustainability (Switzerland)*, 11(7), pp. 0–27. doi: 10.3390/su11071952.

BIANCARDO, S. A. GESUALDI, M. SAVASTANO, D. INTIGNANO, M. HENKE,I. PAGLIARA, F. (2023) **'**An innovative framework for integrating Cost-Benefit Analysis (CBA) within Building Information Modeling (BIM)', *Socio-Economic Planning Sciences*, 85(December 2021), p. 101495. doi: 10.1016/j.seps.2022.101495.

BIANCHI, A. AND DE MEDICI, S. (2023) 'A Sustainable Adaptive Reuse Management Model for Disused Railway Cultural Heritage to Boost Local and Regional Competitiveness', *Sustainability*, 15(6), p. 5127. doi: 10.3390/su15065127.

BIS (2011) 'Infrastructure supply chains: barriers and opportunities', (August), pp. 1–88.

BISHOP, P. A. HERRON, R. L. (2015) 'Use and misuse of the Likert item responses and other ordinal measures', International journal of exercise science. 8(3):297.

BOATENG, P., CHEN, Z. and OGUNLANA, S.O., 2015. An Analytical Network Process model for risks prioritisation in megaprojects. International Journal of Project Management, 33(8), pp.1795-1811.

BOO, Y. AND KWON, Y. S. (2018) 'A Case Study on Sustainable Reuse of Abandoned Infrastructure at Seoul Station Overpass as Urban Park for the Design Strategies in Korea', *IOP Conference Series: Earth and Environmental Science*, 143(1). Institute of Physics Publishing. doi: 10.1088/1755-1315/143/1/012061.

BOND (2019) 'The UK's global contribution to the Sustainable Development Goals. [online]. Available: https://www.bond.org.uk/wp-content/uploads/2023/03/bond_the_uks_global_contribution_to_the_sdgs_online_full_report.pdf

BOSSINK, B. A. G. AND VRIJHOEF, R. (2008) 'Innovation management in the construction supply chain', *Construction Supply Chain Management Handbook*, (August), pp. 14-1-14–21. doi: 10.1201/9781420047462-20.

BOWKER, G. C. (2018). Sustainable knowledge infrastructures. In N. Anand, A. Gupta, & H. Appel (Eds.), The promise of infrastructure. Durham: Duke University Press

BRADLEY, A**.** LI, H. LARK, R. DUNN, S.(2016) 'BIM for infrastructure: An overall review and constructor perspective', *Automation in Construction*, 71, pp. 139–152. doi: 10.1016/j.autcon.2016.08.019.

BRINCK, T., GERGLE, D. AND WOOD, S. D. (2010) *Chapter 2 - User Needs Analysis*. 1st edn, *User Experience Re-Mastered*. 1st edn. Elsevier. doi: 10.1016/B978-0-12-375114-0.00005-0.

BRINKMAN , R.(2020) ' BrinkmannEnvironmental Sustainability in a Time of Change', Palgrave Studies In Environmental Sustainability, Palgrave Macmillan, (eBook), https://doi.org/10.1007/978-3-030-28203-5

BRIS, S.L. MADRID-GUIJARRO, A. MARTIN, D.P.(2019) Decision - making in complex environments under time pressure and risk of critical irreversibility: The role of meta rules', 22, (pp. 1-30), Association Internationale de management strategique (AIMS), DOI 10.3917/mana.221.0001

BRITANNICA (2023) 'Regulation'[online], Available from: Counterintelligence | government operation | Britannica

BROSNAN, K., KEMPERMAN, A. AND DOLNICAR, S. (2021) 'Maximizing participation from online survey panel members', *International Journal of Market Research*, 63(4), pp. 416–435. doi: 10.1177/1470785319880704.

BRYMAN, A. (2012) Social research methods. 4th Edition. Oxford University Press

BRYMAN, A. (2016) *Social Research Methods. 5th Ed. Oxford. Oxford University Press*.

BUBA ET AL. (2016),

BUITELAAR, E., MORONI, S. AND DE FRANCO, A. (2021) 'Building obsolescence in the evolving city. Reframing property vacancy and abandonment in the light of urban dynamics and complexity', *Cities*, 108(September 2020), p. 102964. doi: 10.1016/j.cities.2020.102964.

BULLEN, P. B.(2022) 'How to choose a sample size (for the statistically challenged)', *Tools4Dev*. Available at: https://tools4dev.org/resources/how-to-choose-a-sample-size/.

BUSETTO, L., WICK, W. AND GUMBINGER, C. (2020) 'How to use and assess qualitative research methods'.

BYNUM, P. ISSA, R.R.A. OLBINA, S. (2013) 'Building Information Modeling in Support of Sustainable Design and Construction, Journal of Construction Engineering and Management, 139 (1)

https://doi.org/10.1061/(ASCE)CO.1943-7862.0000560
BYROM, N. (2020) ‘The challenges of lockdown for early-career researchers’, *eLife*, 9, pp. 1–3. doi: 10.7554/ELIFE.59634.

CANADIAN AUDIT AND ACCOUNTABILITY FOUNDATION (CAAF) (2023) ' Homogeneity and Heterogeneity',

CALLEN, T., (2023) ‘Gross Domestic Product: An Economy's All’, *Finance and Development,* file:///H:/PhD%20Study%202/Journal%20References/Gross%20Domestic%20Product%20An%20Economys%20All.pdf

CALTENCO, H. A. BREIDAGARD, B. JONSSON, B. LOTTE, N.S STRUIJK, A. (2012) ‘Understanding Computer Users With Tetraplegia: Survey of Assistive Technology Users’, *International Journal of Human-Computer Interaction*, 28(4), pp. 258–268. doi: 10.1080/10447318.2011.586305.

CAMARINHA, R., (2016). '*Green BIM*' United Kingdom: The BIM Hub. Available from: https://thebimhub.com/2016/05/04/green-bim-5/#.XcQKx0lCfnP

CANHAM, S. (2019) 'Staged completion: It's just a phase'

CANTU, C. (2017) 'Defining Infrastructure and its Effect on Economic Growth', Equilibrio Económico, Revista de Economía, Política y Sociedad. V 13 (1) pp. 77-104

CAO, Y., KAMARUZZAMAN, S. N. AND AZIZ, N. M. (2022) ‘Green Building Construction: A Systematic Review of BIM Utilization’, *Buildings*, 12(8). doi: 10.3390/buildings12081205.

CARIANI, P. (2022) ‘Different Roles for Multiple Perspectives and Rigorous Testing in Scientific Theories and Models: Towards More Open, Context-Appropriate Verificationism’, *Philosophies*, 7(3). doi: 10.3390/philosophies7030054.

CASCONE, S. AND SCIUTO, G. (2018) ‘Recovery and reuse of abandoned buildings for student housing: A case study in Catania, Italy’, *Frontiers of Architectural Research*, 7(4), pp. 510–520. doi: 10.1016/j.foar.2018.08.004.

CASH, P. STANKOVIC, T. AND STORGA, M. (2016) Experimental Design Research Approaches, Perspectives, Applications *(Philip Cash, Tino Stanković, Mario Štorga) (z-lib.org).pdf*.

CASTRO, C.G. TREVISAN, A.H. PIGOSSO, D.C.A. MASCARENHAS, J. (2022) 'The rebound effect of circular economy: Definitions, mechanisms and a research agenda', ELSEVEIR, Journal of Cleaner Production, ScienceDirect, 345 (2022)

CERNEVICIENE, J. AND KABASINSKAS, A. (2022) ‘Review of Multi-Criteria Decision-Making Methods in Finance Using Explainable Artificial Intelligence’, *Frontiers in Artificial Intelligence*, 5(March), pp. 1–16. doi: 10.3389/frai.2022.827584.

CORPORATE FINANCE INSTITUTE (CFI) (2023) ‘Public Infrastructure', [online] Available from: https://corporatefinanceinstitute.com/resources/economics/public-infrastructure/

CHAKRABARTTY, S. N. (2019) ‘Scoring and Analysis of Likert Scale : Few Approaches Scoring and Analysis of Likert Scale : Few Approaches Satyendra Nath Chakrabartty Former Director of Kolkata Campus of Indian Maritime University’, (July 2014).

CHAKRABORTY, S. AND CHATTERJEE, P. (2013) ‘Selection of materials using multi-criteria decision-making methods with minimum data’, *Decision Science Letters*, 2(3), pp. 135–148. doi: 10.5267/j.dsl.2013.03.005.

CHANG, A. CHENG, Y. (2019) ' Analysis model of the sustainability development of manufacturing small and medium- sized enterprises in Taiwan, Journal of Cleaner Production, ELSEVIER, 207 (2019) pp. 458 - 473, [online] Available from: https://doi.org/10.1016/j.jclepro.2018.10.025

CHAN, T. W. LOOI, C. CHANG, B. CHEN, W. WONG, L. WONG, S.L. YU, F. MASON, J. LIU, C. SHIH, J. WU, Y. KONG, S. WU, L. CHIEN, T. LIAO, C.C.Y. CHENG, H. CHEN, Z. CHOU, C. (2019) 'IDC theory: creation and the creation loop', *Research and Practice in Technology Enhanced Learning*, 14(1). doi: 10.1186/s41039-019-0120-5.

CHANG, K. H. (2015) 'Decisions in Engineering Design', *e-Design*, pp. 847–905. doi: 10.1016/b978-0-12-382038-9.00016-8

CHANG, T. Y. AND KU, C. C. Y. (2021) 'Fuzzy filtering ranking method for multi-criteria decision making', *Computers and Industrial Engineering*, 156(February), p. 107217. doi: 10.1016/j.cie.2021.107217.

CHAPMAN, B. (RTI) INTERNATIONAL POLICE EXECUTIVE RESEARCH FORUM (2017) 'Research on the Impact of Technology on Policing Strategy in the 21st Century', Final Report, National Criminal Justice Reference Service (NCJRS).

CHARTERED INSTITUTE OF ECOLOGY AND ENVIRONMENTAL MANAGEMENT (CIEEM) (2018) 'Guidelines for ecological impact assessment in the UK and Ireland', Terrestrial, Freshwater, Coastal and Marine. [online] Available from: https://cieem.net/wp-content/uploads/2019/02/Combined-EclA-guidelines-2018-compressed.pdf

CHEN, C. H. (2020) 'A novel multi-criteria decision-making model for building material supplier selection based on entropy-AHP weighted TOPSIS', *Entropy*, 22(2), pp. 10–12. doi: 10.3390/e22020259.

CHEPKEMOI, J. (2019) 'How many countries are in africa?' [online] Canada: Worldatlas. Available from: https://www.worldatlas.com/articles/how-many-countries-are-in-africa.html

CHESHIRE, T. (2017) 'BIM is changing architecture - not necessarily for the better | WIRED UK', *Wired*.

CHETTY, P. (2016) 'Importance of ethical considerations in a research | Knowledge Tank', *Project Guru*, pp. 1–4. Available at: https://www.projectguru.in/publications/importance-ethical-considerations-research/.

CHIDI, O. B**.** CHUKS, O.K. IKEM, M. AUSTINE, A.I**.** (2019) 'A study of the relationship between the office building performance and user productivity in anambra state, Nigeria', International Journal of Applied Science and Research, pp. 1–7.

CHINOWSKY, P. AND HELMAN, J. (2021) 'Protecting infrastructure and public buildings against sea level rise and storm surge', *Sustainability (Switzerland)*, 13(19), pp. 1–20. doi: 10.3390/su131910538.

CHISA, O. S., KAYODE, V., IKENI, N. O., & GAMBO, A. A. I. (2015). 'Public- private partnership (PPP) as catalyst for sustainable infrastructural development (Effort of rivers, cross rivers, Oyo and Lagos State government)'. International Journal of Engineering Science Invention, 4, 53-69.

CHIUMENTO, A., RAHMAN, A. AND FRITH, L. (2020) 'Writing to template: Researchers' negotiation of procedural research ethics', *Social Science and Medicine*. doi: 10.1016/j.socscimed.2020.112980.

CHONG, H., LEE, C., WANG, X. (2017) 'A mixed Review of the adoption of Building Information Modelling (BIM) for sustainability', 142, pp. 4114–4126. doi: 10.1016/j.jclepro.2016.09.222.

CHRIS, R. (2019) 'Construction industry statistics policy'. [online] United Kingdom: House Of Commons Library. Available from: https://researchbriefings.files.parliament.uk/documents/SN01432/SN01432.pdf

CIRRINCIONE, L**.** SCACCIANOCE, G. PERI, G. PALERMO, S. RIZZO, G. (2022) 'The Role of Local Administrations in the Energy Retrofit of Public Buildings: a Case Study', *2022 IEEE International*

Conference on Environment and Electrical Engineering and 2022 IEEE Industrial and Commercial Power Systems Europe, EEEIC / I and CPS Europe 2022. doi: 10.1109/EEEIC/ICPSEurope54979.2022.9854710.

COLE, P. (2022) 'Nigeria and abandoned projects', *The Guardian*. [Online] Available: https://guardian.ng/opinion/nigeria-and-abandoned-projects/

CONATY, F. (2021) 'Abduction as a Methodological Approach to Case Study Research in Management Accounting — An Illustrative Case', 2018, pp. 1–26.

CONNOLLY, S.(2020) ' The Regulation of Pork Barrelling in Australia, University of Queensland, Double-blind reviewed article, pp 24-35

CONTRERAS, D. BLASCHKE, T. KIENBERGER, S. ZEIL, P. (2013) 'Spatial connectivity as a recovery process indicator: The L'Aquila earthquake', Technological Forecasting & Social Change, ELSEVIER, 80 (2013), pp. 1782-1803, https://doi.org/10.1016/j.techfore.2012.12.001

COOMBS, H. (2022) 'Case study research Defined (White Paper)', *Psychoanalysis Online 4*, (September 2022), pp. 49–59. doi: 10.4324/9780429458248-7.

COSTA, E., LUCAS SOARES, A. AND PINHO DE SOUSA, J. (2017) 'Institutional networks for supporting the internationalisation of SMEs: the case of industrial business associations', *Journal of Business and Industrial Marketing*, 32(8), pp. 1182–1202. doi: 10.1108/JBIM-03-2017-0067.

CRESWELL, J.W. (2013) ' Qualitative Inquiry and Research Design: Choosing Among Five Approaches

CRESWELL, J. W. (2014). Research Design: Qualitative, Quantitative and Mixed Methods Approaches (4th ed.). Thousand Oaks, CA: Sage

CRESWELL, J.W. and J. DAVID CRESWELL (2017) 'Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications.

CRESWELL, J. W., AND CRESWELL, J. D. (2018) 'Qualitative inquiry and research design: Choosing among five approaches', Sage publications.

CRESWELL, J.W. and POTH, C.N. (2018) 'Qualitative inquiry and research design: Choosing among five approaches', (4th ed.). Washington DC: Sage publications.

CROATTO, G., TURRINI, U. AND BERTOLAZZI, A. (2017) 'Criteria and guidelines about structural reversibility for reinforced concrete historical buildings refurbishment. The excelsior cinema in Milan (1926-30)', *Journal of Architectural Conservation*, 22(3), pp. 189–198. doi: 10.1080/13556207.2017.1279866.

CSEEES (CENTER FOR SLAVIC AND EAST EUROPEAN STUDIES) (2023) ' End of Cold War', *Library of Congress Teaching, Primary Source Eastern Region Program, Waynesburg University, [*ONLINE] Available: End of the Cold War | A Visual Guide to the Cold War (unc.edu)

CSER (2019) 'Alpha testing vs Beta testing. Why they matter for you' , [online], Available from : https://www.functionize.com/blog/alpha-testing-vs-beta-testing-why-matter

CENTRAL UNIVERSITY RESEARCH ETHICS COMMITTEE (CUREC) (2020) 'Conducting research interviews', Best Practice Guidance 10_Version 1.0, University of OIxford.

DAMOAH, I. S., MOUZUGHI, Y. AND KUMI, D. K. (2020) 'The effects of government construction projects abandonment: stakeholders' perspective', *International Journal of Construction Management*, 20(5), pp. 462–479. doi: 10.1080/15623599.2018.1486172.

DANIEL, B.K. (2018) 'REImaging Research Methodology as Data Science', Big data and cognitive computing, MDPI, 2(4), [online] Available from: http://dx.doi.org/10.3390/bdcc2010004

DANIEL, E. (2016) 'The Usefulness of Qualitative and Quantitative Approaches and Methods in Researching Problem-Solving Ability in Science Education Curriculum', Journal of Education and Practice, ERIC, 7(15), pp. 91-100.

DANIEL, C.O., IBRAHIM, A. U. (2019) 'International Journal of Research in Business , Economics and Management Project Failure and Its Influence On the Performance of Construction Firms in Nigeria International Journal of Research in Business , Economics and Management', 3(2), pp. 86–95.

DANIOTTI, B**.** BOLOGNESI, C.M. SPAGNOLO, S.L. PAVAN. A. CIUFFREDA, S. MIRARCHI. C. LUCKY, M.N. ANDERSSON, B. ANDERSSON, P. VALRA, A. MADEDDU, D. CHIAPPETTI, J. FARINA, D. O'REGAN, B. O'LEIDHIN, E. TAHIR, F. MOULD, K. O'DONOVAN, S. O'SULLIVAN, S. HRYSHCHENKO, A. O'SULLIVAN, D. (2021) **'**An interoperable bim-based toolkit for efficient renovation in buildings', *Buildings*, 11(7), pp. 1–16. doi: 10.3390/buildings11070271.

DAS, R., JAIN, K. K. AND MISHRA, S. K. (2018) 'Archival research : a neglected method in organization studies'. doi: 10.1108/BIJ-08-2016-0123.

DAVID, A., THANGAVEL, Y. D. AND SANKRITI, R. (2019) 'Recover, recycle and reuse: An efficient way to reduce the waste', *International Journal of Mechanical and Production Engineering Research and Development*, 9(3), pp. 31–42. doi: 10.24247/ijmperdjun20194.

DAVID, B. RESNIK, J.D. (2015) 'What is ethics in research & why is it important? [online] United State of America: National Institutes of Environmental health Sciences', Available from: https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm

DAVIES, O. AND DAVIES, I. (2017) 'Barriers to Implementation of Sustainable Construction Techniques', *MAYFEB Journal of Environmental Science -*, 2, pp. 1–9.

DAVIS, R. PATEL, T. GOLDSMITH, J.(2013) 'Sustainable procurement in government', National Audit Office (NAO), *Briefing for the House of Commons environmental audit select committee, pp 1-32.*

DAWADI, S., SHRESTHA, S. AND GIRI, R. A. (2021) 'Mixed-Methods Research: A Discussion on its Types, Challenges, and Criticisms', *Journal of Practical Studies in Education*, 2(2), pp. 25–36. doi: 10.46809/jpse.v2i2.20.

DAWSON, S. MANDERSON, L. and TALLO, V.L. (1993) 'A manual for the use of focus groups', Boston: international Nutrition foundation for developing countries. DENZIN, N. 2010. Moments, mixed methods, and paradigm dialogs. Qualitative Inquiry 16: 419–427.

DAWSON, C. (2011) *Introduction to Research Methods: A practical Guide For Anyone Undertaking A Research Project*. London: How To Book Limited.

DECKER, S. (2013) 'The silence of the archives: Business history, post-colonialism and archival ethnography', *Management and Organizational History*, 8(2), pp. 155–173. doi: 10.1080/17449359.2012.761491.

DEFAZIO, P.A. (2021) 'The cost of doing nothing: why investing in our nation's infrastructure cannot wait', Hearing before the committee on transportation and infrastructure house of representatives one hundred sixteenth congress first session. U.S. Government publishing office, Washington.

DEJONCKHEERE, M. AND VAUGHN, L. M. (2019) 'Semistructured interviewing in primary care research : a balance of relationship and rigour', (p 1), pp. 1–8. doi: 10.1136/fmch-2018-000057.

DELOITTE (2015) 'Economic benefits of better procurement practices', p. 94. Available at: www.deloitte.com/au/about.

DENNING, R.(2012) 'Applied R&M Manual for Defence Systems', (GR-77 Issue 2012), Version 2.5

DE-MATOS, E.C.B. MOREIRA, A.M. NETO, J.B.D.S. (2016) 'An empirical study of test generation with BETA', Journal of the Brazilian Computer Society, SpringerOpen, 22(8), DOI 10.1186/s13173-016-0048-1

DEPOY, E. AND GITLIN, L. N. (2016) 'Formulating Research Questions and Queries', *Introduction to Research*, (Chapter 5), pp. 97–111. doi: 10.1016/b978-0-323-26171-5.00008-2.

DESHPANDE, K. (2019) *Classification*. doi: 10.1016/B978-0-12-814761-0.00004-6.

DESIGNING BUILDING (2022) 'Building Survey', The Construction Wiki, [online] Available from: https://www.designingbuildings.co.uk/wiki/Building_survey

DESIGNING BUILDINGS (2023) 'Refurbishment', Circular Economy Wiki, [online] Available from: https://www.designingbuildings.co.uk/wiki/Refurbishment

DEWULF, J.; VAN LANGENHOVE, H.; MULDER, J.; VAN DEN BERG, M.M.D.; VAN DER KOOI, H.J.; DE SWAAN ARONS, J. (2000) 'Illustrations towards quantifying the sustainability of technology', Green Chem. 2, 108–114.

DIM, N. EZEABASILI, A. C. (2015) 'Strategic Supply Chain Framework as an Effective Approach to Procurement of Public Construction Projects in Nigeria', *International Journal of Management and Sustainability*, 4(7), pp. 163–172. doi: 10.18488/journal.11/2015.4.7/11.7.163.172.

DING, L., ZHOU, Y. AND AKINCI, B. (2014) 'Building Information Modeling (BIM) application framework: The process of expanding from 3D to computable nD', *Automation in Construction*, 46, pp. 82–93. doi: 10.1016/j.autcon.2014.04.009.

DINIKA, A. (2022) 'Digital Sovereignty: African Perspectives', (February). doi: 10.5281/zenodo.5851685.

DIPANKAR DEB, K. B. (2022) 'Optimization of on-site PID detection methods', pp. 133–149. doi: 10.1016/B978-0-12-823483-9.00019-X.

DJOKOTO, J. G. (2022) 'The investment development path and human development: Is there a nexus?', *Research in Globalization*, 4(October 2021), p. 100079. doi: 10.1016/j.resglo.2021.100079.

DORAISAMY, V., S., AKASHA, Z. A. AND YUNUS, R. (2015) 'A Review on Abandoned Construction Projects: Causes & Effects', *Applied Mechanics and Materials*, 773–774(July), pp. 979–983. doi: 10.4028/www.scientific.net/amm.773-774.979.

DOUVEN, I. (2021) 'Abduction (Stanford Encyclopedia of Philosophy)', Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/entries/abduction/

DUDOVSKIY, J. 2016. 'The Ultimate Guide to Writing a Dissertation in Business Studies: A Step-by-Step Assistance', July 2016 edition, eBook Journal of Mixed Methods Research 4(1). pp.6–16

DUFFETT, R. AND WAKEHAM, M. (2023) 'Modeling a New Supplier Preference Paradigm: A Business-to-Business and African Developing Economy Context', *Sustainability (Switzerland)*, 15(1). doi: 10.3390/su15010411.

DUIGNAN, B. (2020) ' Reductionism : philosophy', Britannica Encyclopedia, [online], Available from: https://www.britannica.com/topic/reductionism.

DUNCAN, S. (2023) 'Advantages & Disadvantages Of Swot Analysis For Businesses', Real Business, [online] Available from : https://realbusiness.co.uk/advantages-and-disadvantages-of-swot-analysis

DUNNE, R. (2021) 'Public VS Private Sector Employment 6 Advantages of Working on Both Sides.pdf'.

DURMUSOGLU, Z. D. AND DURMUŞOĞLU, A. (2021) 'A TOPSIS model for understanding the authors choice of journal selection', Scientometrics, 126(1), pp. 521–543. doi: 10.1007/s11192-020-03770-5.

DWORKIN, S. L. (2012) 'Sample size policy for qualitative studies using in-depth interviews', Archives of Sexual Behavior, 41(6), pp. 1319–1320. doi: 10.1007/s10508-012-0016-6.

DYER, M. DYER, R. WENG, M. WU, S. GREY, T. GLEESON, R. FERRARI, T.G**.** (2019) 'Framework for soft and hard city infrastructures', *Proceedings of the Institution of Civil Engineers: Urban Design and Planning*, 172(6), pp. 219–227. doi: 10.1680/jurdp.19.00021.

EAGLE, A. GLITHERO, T. GOSTICK, J. LOSSE, K. WILDING, E. (2020) 'Environmental Sustainability Overview', Minstry of Defence (MOJ), National Audit Office (NAO). [online] Available from: https://www.nao.org.uk/wp-content/uploads/2020/05/Environmental-Sustainability-Overview.pdf

EBNEYAMINI, S., REZA, M. AND MOGHADAM, S. (2018) 'Toward Developing a Framework for Conducting Case Study Research', 17, pp. 1–11. doi: 10.1177/1609406918817954.

EDUN ADETUNJI OLUFEMI, OLATUNBOSUN, A. J., OLASODE, O. S. AND ADENIRAN, I. G. (2013) 'Infrastructural Development and Its Effect on Economic Growth : the Nigerian Perspective', *European Scientific Journal*, 9(31), pp. 431–452.

EDWARDS, R. E. LOU, E. BATAW, A. KAMARUZZAMAN, S.N. JOHNSON, C. (2019) 'Sustainability-led design: Feasibility of incorporating whole-life cycle energy assessment into BIM for refurbishment projects', *Journal of Building Engineering*, 24(January), p. 100697. doi: 10.1016/j.jobe.2019.01.027.

EINOLA, K. AND ALVESSON, M. (2021) 'Behind the Numbers: Questioning Questionnaires', *Journal of Management Inquiry*, 30(1), pp. 102–114. doi: 10.1177/1056492620938139.

EKELE, O. ENEJO, W. YAHAYA, L. ISAAC, J. (2022) 'Effect of Public Projects Abandonment on Clients and Host Communities : The Case of Dekina Local Government Area of Kogi State , Nigeria', 7(6), pp. 33–43.

ELAATI, A. A. N. (2016) 'Postmdernism Theory', (June). doi: 10.13140/RG.2.1.4515.0327.

ELIJAH OLUSEGUN, A. AND OLUMUYIWA MICHAEL, A. (2011) 'Abandonment of Construction Projects in Nigeria: Causes and Effects', *Journal of Emerging Trends in Economics and Management Sciences*, 2(2), pp. 2141–7024. Available at: http://jetems.scholarlinkresearch.com/articles/Abandonment of Construction Projects in Nigeria.pdf.

EMAS, R. (2015) 'The Concept of Sustainable Development : Definition and Defining Principles. Brief for GSDR 2015'.

EMOVON, I. AND OGHENENYEROVWHO, O. S. (2020) 'Results in Materials Application of MCDM method in material selection for optimal design : A review', *Results in Materials*, 7(June), p. 100115. doi: 10.1016/j.rinma.2020.100115.

EMUCHAY, C. U. AND OJAPAH, M. M. (2021) 'Analysis of Subsea Energy Supply Systems for Improved Maintenance Using ANFIS and TOPSIS', *Innovative Systems Design and Engineering*, 12(2), pp. 8–19. doi: 10.7176/isde/12-2-02.

EMUZE, F. AND KADANGWE, S. (2014) 'Diagnostic view of road projects in Malawi', *Proceedings of the Institution of Civil Engineers: Municipal Engineer*, 167(1), pp. 44–55. doi: 10.1680/muen.13.00003.

ERDOGAN, S. A., ŠAPARAUSKAS, J. AND TURSKIS, Z. (2019) 'A multi-criteria decision-making model to choose the best option for sustainable construction management', *Sustainability (Switzerland)*, 11(8). doi: 10.3390/su11082239.

ERDOGAN, S.A. ŠAPARAUSKAS, J. TURSKIS, Z. (2017) ' Decision Making in Construction Management: AHP and Expert Choice Approach', Modern Building Materials, Structures and Techniques, MBMST 2016, ELSEVIER, Procedia Engineering 172 (2017) pp. 270 – 276

ETZKORN, B. (2015) 'Data Normalization and Standardization' [online] http://www.benetzkorn.com/2011/11/data-normalization-and-standardization/

EUGENIA SAN SEGUNDO, ATHANASIOS TSANAS, P. G.-V. (2017) 'Euclidean Distances as measures of speaker similarity including identical twin pairs : A forensic investigation using source and fi lter voice characteristics', *Forensic Science International*, 270, pp. 25–38. doi: 10.1016/j.forsciint.2016.11.020.

EZENEKWE, U. . AND UZONWANNE, M. . (2017) 'Effects of abandoned highway construction project in the Nigerian economy: a case study of Enugu-Onitsha highway road', *Journal of economics and sustainable development*, 8(10), pp. 30–34.

FABOZZI, S. BIANCARDO, S.A. VEROPALUMBO, R. BILOTTA E. (2021) 'I-BIM based approach for geotechnical and numerical modelling of a conventional tunnel excavation', Tunn Undergr Space Technol 2021;108(2021):103723. https://doi.org/10.1016/j.

FADASON, R. DANLADI, C. AND SHARON, J.T. (2017) 'Construction Standard and Regulation in Nigeria', FIG Working Week 2017, Surveying the world of tomorrow - From digitalisation to augmented reality Helsinki, Finland, May 29–June 2, 2017. Pp:1-15, [online], Available from: https://www.fig.net/resources/proceedings/fig_proceedings/fig2017/papers/ts07d/TS07D_fadason_danladi_et_al_8746_abs.pdf

FANG, X. ZOU, J. WU, Y. ZHANG, Y. ZHAO, Y. ZHANG, H. (2021) 'Evaluation of the sustainable development of an island "Blue Economy": A case study of Hainan, China', Sustainable Cities and Society, 66(36), p. 102662. doi: 10.1016/j.scs.2020.102662.

FARDET, A. AND ROCK, E. (2015) 'From a reductionist to a holistic approach in preventive nutrition to define new and more ethical paradigms', *Healthcare (Switzerland)*, 3(4), pp. 1054–1063. doi: 10.3390/healthcare3041054.

FARIA, S. V. DE**.** ZUFFO, L.T. REZENDE, W.M. CHIPETA, D.G. PEREIRA, H.D. AZEVEDO, C.F. DELIMA, R.O**.** (2022) 'Phenotypic and molecular characterization of a set of tropical maize inbred lines from a public breeding program in Brazil', pp. 1–17.

FATIHUDIN, D., JUSNI AND MOCHKLAS, M. (2018) 'How measuring financial performance', *International Journal of Civil Engineering and Technology*, 9(6), pp. 553–557.

FATTORUSO, G. (2022) 'Multi-Criteria Decision Making in Production Fields: A Structured Content Analysis and Implications for Practice', *Journal of Risk and Financial Management*, 15(10). doi: 10.3390/jrfm15100431.

FAZELI, A**.** JALAEI, F. KHANZADI,M. BANIHASHEMI, S. (2019) **'**BIM-integrated TOPSIS-Fuzzy framework to optimize selection of sustainable building components', *International Journal of Construction Management*, 0(0), pp. 1–20. doi: 10.1080/15623599.2019.1686836.

FEDERAL REPUBLIC OF NIGERIA (2017) 'Implementation of the SDGs: A National Voluntary Review', pp. 1–100. Available at: https://sustainabledevelopment.un.org/content/documents/16029Nigeria.pdf.

FEIZABADI, A. DOOLABI, M.S. SADRNEZHAAD, S.K. ZAFARANI, H.R. DOOLABI, D.S. ASADIZARCH, M. (2017) 'MCDM selection of pulse parameters for best tribological performance of CreAl2O3 nano-composite co-deposited from trivalent chromium bath', Journal of Alloys and Compounds, ELSEVIER, 727 (2017) pp. 286 - 296,

FEROZ. A. K. ZO, H. CHIRAVURI, A (2021) 'Digital transformation and environmental sustainability: A review and research agenda', Sustainability, MDPI, 13(3) 1530; https://doi.org/10.3390/su13031530

FERRET, J., PIETQUIN, O. AND GEIST, M. (2020) 'Self-imitation advantage learning', *Proceedings of the International Joint Conference on Autonomous Agents and Multiagent Systems, AAMAS*, 1, pp. 501–509.

FOGARASSY-NESZLY, P. AND ZINVELIU, Z. (2015) 'A Software Component for Polyglot Text-to-Speech Synthesis : User Interface and Beta Testing Results', (September), pp. 145–148.

FONSECA, X., LUKOSCH, S. AND BRAZIER, F. (2019) 'Social cohesion revisited: a new definition and how to characterize it', *Innovation: The European Journal of Social Science Research*, 32(2), pp. 231–253. doi: 10.1080/13511610.2018.1497480.

FOSTER, G. (2020). Circular economy strategies for adaptive reuse of cultural heritage buildings to reduce environmental impacts. *Resources, Conservation and Recycling*, *152*(October 2019), 104507. https://doi.org/10.1016/j.resconrec.2019.104507

FOSTER, V., RANA, A. AND GORGULU, N. (2022) ‘Understanding Public Spending Trends for Infrastructure in Developing Countries’, (January). Available at: https://openknowledge.worldbank.org/handle/10986/36849.

FRENCH, H.W. (2022) 'Megalopolis: how coastal west Africa will shape the coming century', Guardian News & Media Limited or its affiliated companies. [Online]. Available from: https://www.theguardian.com/world/2022/oct/27/megalopolis-how-coastal-west-africa-will-shape-the-coming-century

FUCHS, A. (2021) ‘Khutsong Clinic abandoned – DA Gauteng’, (September 2019), pp. 1–6.

GAAL, O. H. AND AFRAH, A. N. (2017) ‘Lack of infrastructure: The impact on economic development as a case of Benadir region and Hir-shabelle, Somalia’, *Developing Country Studies*, 7(1), pp. 49–55. Available at: https://www.semanticscholar.org/paper/Lack-of-Infrastructure-%3A-The-Impact-on-EconoMIC-AS-GAAL.

GALDINO DE FREITAS, J., GOMES COSTA, H., TOLEDO FERRAZ, F., 2017. 'Impacts of Lean Six Sigma over organizational sustainability: a survey study'. J. Clean. Prod. 156, 262e275.

GANDHI, S. JUPP, J.R., (2013) 'Characteristics of Green BIM: Proces and Informaion Management Requirement',. In: A.J. TURNER, ed. *10th (IFIP -The Internaional Federation for Informaion Processing) International Conference.* July 2013. France: Springer Heidelberg. pp. 596-605

GAO, R. NAM, H.O. KO, W.I. JANG, H. (2017) ‘National options for a sustainable nuclear energy system: MCDM evaluation using an improved integrated weighting approach’, *Energies*, 10(12). doi: 10.3390/en10122017.

GARBA, Y. Y. (2019) ‘Effect of Abandoned building Projects on the Neighbourhood of Abuja, Nigeria’, *Environmental Technology & Science Journal*, 10(2), pp. 19–22. Available at: http://repository.futminna.edu.ng:8080/jspui/handle/123456789/9759.

GARTNER (2023) ‘GUI (Graphical User Interface) 13.2’, Area, pp. 134–142.

GBADAMOSI, A. (2023) ‘Understanding the Developed Developing Country Taxonomy.pdf’.

GEBRE, S. L. CATTRYSSE, D. ALEMAYEHU, E. ORSHOVEN, J.V**.** (2021) ‘Multi-criteria decision making methods to address rural land allocation problems: A systematic review’, *International Soil and Water Conservation Research*, 9(4), pp. 490–501. doi: 10.1016/j.iswcr.2021.04.005.

GEDDES, B., FRANTZ, E. AND WRIGHT, J. G. (2014) ‘Military rule’, *Annual Review of Political Science*, 17, pp. 147–162. doi: 10.1146/annurev-polisci-032211-213418.

GEORANK (2022) 'Nigeria vs the United Kingdom: Economic indicators Comparison' [online], Available from: https://georank.org/economy/nigeria/united-kingdom

GHIANI, G., MANCA, M. AND PATERNÒ, F. (2015) ‘Authoring context-dependent cross-device user interfaces based on trigger/action rules’, *ACM International Conference Proceeding Series*, 30-November-2015(Mum), pp. 313–322. doi: 10.1145/2836041.2836073.

GHORPADE, K. H. AND VASATKAR, P. A. R. (2015) ‘Selection Of Most Suitable Contractor By Using MCDM Techniques’, 1(5).

GHOSH, A DAS, S. (2013) ' Raw Jute Grading By Multi-Criteria Decision-Making Method', Journal of Natural Fibers, Taylor & Francis, 10 (2), pp.136-146. [online]. Available from: http://dx.doi.org/10.1080/15440478.2012.763203

GIANGRANDE, N. WHITE, R.M. EAST, M. CLARKE, T. COSTE, M.S. PENHA-LOPES, G. (2019) ‘A competency framework to assess and activate education for sustainable development: Addressing the UN sustainable development goals 4.7 challenge’, *Sustainability (Switzerland)*, 11(10), pp. 1–16. doi:

10.3390/su11102832.

GIBLING, M. R. BASHFORTH, A.R. FALCON-LANG, H.J. ALLEN, J.P. FIELDING, C.R. (2010) 'Log jams and flood sediment buildup caused channel abandonment and avulsion in the pennsylvanian of atlantic Canada', *Journal of Sedimentary Research*, 80(3–4), pp. 268–287. doi: 10.2110/jsr.2010.024.

GILBERT, R. (2018) 'How to sell off council properties properly?', Local Government Lawyer, [online], Available from: Local Government Lawyer

GLOBAL ECONOMY (2023) 'Compare countries with annual data from official sources'. [online] Available: https://www.theglobaleconomy.com/compare-countries/

GODWIN, A. BENEDICT, B. ROHDE, J. THIELMEYER, A. PERKINS, H. MAJOR, J. CLEMENTS, H. CHEN, Z. (2021) 'New Epistemological Perspectives on Quantitative Methods: An Example Using Topological Data Analysis', *Studies in Engineering Education*, 2(1), p. 16. doi: 10.21061/see.18.

GONI, F. A. CHOFREH, A.G. ORAKANI, Z.E. KLEMEŠ, J.J. DAVOUDI, M. MARDANI, A. (2021) 'Sustainable business model: A review and framework development', Clean Technologies and Environmental Policy, 23(3), pp. 889–897. doi: 10.1007/s10098-020-01886-z.

GOUNDER, S. (2012) 'Chapter 3 - Research methodology and research questions', (March 2012), pp. 84–193.

GOVANI, J. SINGH, E. KUMAR, A. ZACHARIA, M. RENA, KUMAR, S. (2021) 'New generation technologies for solid waste management', Current Developments in Biotechnology and Bioengineering. BV. doi: 10.1016/b978-0-12-821009-3.00015-4.

GOVERNMENT, H. (2020) 'The Construction Playbook', *The Intersections of the Public and Private Spheres in Early Modern England*, (December), pp. 181–204. doi: 10.4324/9781315036557-9.

GOVINDAN, K., KHODAVERDI, R., JAFARIAN, A., 2013. 'A fuzzy multi criteria approach for measuring sustainability performance of a supplier based on triple bottom line approach', J. Clean. Prod. 47, 345e354.

GOYAL, S., ESPOSITO, M. AND KAPOOR, A. (2016) 'Circular economy business models in developing economies: Lessons from India on reduce, recycle, and reuse paradigms', *Thunderbird International Business Review*, 60(5), pp. 729–740. doi: 10.1002/tie.21883.

GRAHAM, J., GREWAL, I. AND LEWIS, J. (2007) 'Ethics in social research: the views of research participants', *Methodology*, pp. 1–54. Available at: papers2://publication/uuid/28EC6573-5431-44B6-8A38-2D3CCB07F6CC.

GRANER (2017) 'URBANET | Why should we deal with abandoned urban spaces?', *Urbanet*, p. 1. Available at: https://www.urbanet.info/abandoned-urban-spaces/.

GUIA, B. (2020) 'Sustainability Competences: A systematic literature review', Publications Office of the European Union, [online] Available from: doi:10.2760/200956, JRC123624.

GUL, M. CELIK, E. GUMUS, A.T. GUNERI, A.F. (2018) 'A fuzzy logic based PROMETHEE method for material selection problems', *Beni-Suef University Journal of Basic and Applied Sciences*, 7(1), pp. 68–79. doi: 10.1016/j.bjbas.2017.07.002.

GUNN, S. BUTLER, R. DE BLOCK, G. HOGHOJ, M. THELLE, M. (2022) 'Cities, infrastructure and the making of modern citizenship: the view from north-west Europe since c. 1870', *Urban History*, pp. 1–19. doi: 10.1017/S0963926821000882.

GOU, Z.; XIE, X. (2017) 'Evolving green building: Triple bottom line or regenerative design?' J. Clean. Prod. 2017, 153, 600–607

GOUNDAR, S. (2012) 'Research Methodology and Research Method', Chapter 3: . In S. Goundar (Ed.), Cloud Computing. Research Gate Publications

GUPTA, JANMEJOY AND CHAKRABORTY, M. (2021). Energy efficiency in buildings. In *Energy Efficiency Research*. INC. https://doi.org/10.1016/b978-0-12-822989-7.00016-0

HAMMA-ADAMA, M. KOUIDER, T. SALMAN, H.(2018), State of Building Information Modelling (BIM) adoption in Nigeria', 34th Association of Researchers in Construction Management (ARCOM) annual conference, Belfast, UK.

HAMMA-ADAMA, M. (2020) ' Framework for macro building information modelling (BIM) adoption in Nigeria', A thesis submitted in partial fulfilment of the requirements of the Robert Gordon University for the degree of Doctor of Philosophy in Construction Engineering.

HAMMA-ADAMA, M. OGUNNUSI, M. MASHWAMA, N.X., AHMAD, A.-B.S. AND ABBA, H.A. (2021) 'Assessment of Risk Associated with Road Infrastructure Development in the Developing Countries', *Gsj*, 9(7), pp. 1223–1229. Available at: www.globalscientificjournal.com.

HAN , X. SU, J. THIA, J.P. (2020) ' Impact of Infrastructure Investment on Developed and Developing Economies', Asian Infrastructure investment bank, pp. 1-25

HANACHOR, M. E. (2012) 'Community Development Project Abandonment in Nigeria : Causes and Effect s', *Journal of Education and Practice*, 3(6), pp. 33–37.

HANINE, M. BOUTKHOUM, O. TIKNIOUINE, A. AGOUTI, T. (2016) 'Application of an integrated multi-criteria decision making AHP-TOPSIS methodology for ETL software selection', *SpringerPlus*, 5(1). doi: 10.1186/s40064-016-1888-z.

HART, C. (2018) 'Doing your literature review: Releasing the social science research imagination', Sage Study Skill - A book.

HARVEY, F.(2023) ' UK missing climate targets on nearly every front, say government's advisers', Guardian News & Media Limited, [online], Available from: https://www.theguardian.com/technology/2023/jun/28/uk-has-made-no-progress-on-climate-plan-say-governments-own-advisers

HAYTON, E. (2023) ' What is a User Manual? Build a Better User Experience', [online] Available from : https://scribehow.com/library/what-is-a-user-manual

HEINRICHS, H. AND BIERMANN, F. (2016) 'Sustainability Science', *Sustainability Science*, (October). doi: 10.1007/978-94-017-7242-6.

HM GOVERNMENT (2019) 'Voluntary National Review of progress towards the sustainable development goals', United United of Great Britain and Northern Ireland, June 2019. https://sustainabledevelopment.un.org/content/documents/23678UK_12072019_UK_Voluntary_National_Review_2019.pdf

HM GOVERNMENT (2022) 'The Construction Playbook : Government Guidance on sourcing and contracting public works projects and programmes' Version 1.1, [ONLINE] Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1102386/14.116_CO_Construction_Playbook_Web.pdf

HMC ARCHITECTS, 2020. *Repurposing vacant buildings: Sustainable solutions for civic urban spaces.* [online] Available from :https://www.refworks.com/refworks2/default.aspx?r=references|MainLayout::init

HODKINSON, D. 'Fear of Missing Out' (FOMO) marketing appeals: A conceptual model', Journal of Marketing Communications, Routledge Taylor and Francis Group, 25 (1), [online], DOI:

10.1080/13527266.2016.1234504

HOE, Y. E. (2013) 'Causes of Abandoned Construction Projects In Malaysia', *Thesis*, (May).

HORVATH, I. (2016) 'Theory Building in Experimental Design Research', Chapter 12, Experimental Design Research, Approaches, Perspectives, Applications Springer International Publishing Switzerland, P. Cash et al. (eds.), Experimental Design Research, DOI 10.1007/978-3-319-33781-4_12

HOURNEAUX, F., GABRIEL, M. L. DA S. AND GALLARDO-VÁZQUEZ, D. A. (2018) 'Triple bottom line and sustainable performance measurement in industrial companies', Revista de Gestao, 25(4), pp. 413–429. doi: 10.1108/REGE-04-2018-0065.

HRZENJAK, B. (2023) 'What is BETA testing?', [online] Available from: https://www.shakebugs.com/blog/what-is-beta-testing/

HULL, S. (2021) 'Abandoned Construction Sites in Gauteng – Why ? L2B Blog Subscribe', pp. 1–8

HUMPHREY, S.(2023) 'We must learn to love old and unattractive buildings', Construction Management, CIOB, [online]. Available from: https://constructionmanagement.co.uk/construction-must-change-mindset-to-succeed-with-retrofitting/

HUSIN, C. S. M., MOHD ZAKI, N. I. AND ABU HUSAIN, M. K. (2019) 'Implementing sustainability in existing building through retrofitting measures', *International Journal of Civil Engineering and Technology*, 10(1), pp. 1450–1471.

HUSSAIN, S. MAQBOOL, R. HUSSAIN, A. ASHFAQ, S. (2022) 'Assessing the Socio-Economic Impacts of Rural Infrastructure Projects on Community Development', *Buildings*, 12(7). doi: 10.3390/buildings12070947.

IBEM, E. ALAGBE, O. OWOSENI, A. (2017) ' A study of students' perception of the learning environment: case study of department of architecture, covenant university, Ota Ogun state', Proceedings of INTED2017 Conference 6th-8th March 2017, Valencia, Spain, pp. 6275 - 6286

IBUNGE, B. (2023) 'Over 56,000 Projects Abandoned in Nigeria, Says CIPMN', THISDAY NEWSPAPERS LTD, [online]. Available from: https://www.thisdaylive.com/index.php/2022/12/20/over-56000-projects-abandoned-in-nigeria-says-cipmn

INTERNET ENCYCLOPAEDIA OF PHILOSOPHY (IEP) (2021) 'Epistemology', [online] Available from: https://iep.utm.edu/epistemo/

INFRASTRUCTURE CONCESSION REGULATORY COMMISSION Act (ICRC) (2005) 'Infrastructure concession regulatory commission act' [online] Available from: https://www.icrc.gov.ng/portfolio-item/infrastructure-concession-regulatory-commission-act/

IHUAH, PAULINUS WOKA1 & BENEBO, A. M. (2018) 'An assessment of the causes and effects of abandonment of development projects on real property values in nigeria', *The Pacific Journal of Science and Technology*, 19(2), pp. 187–195.

IHUGBA, B. U. DANWANKA, S. OGUCHE, S. OMOTEKORO, J.E (2019) 'Revisiting the Prohibition of Private Practice for Public Officers in Nigeria and its implication on provision of technical services: The Case of Law Lecturers By Bethel Uzoma Ihugba , Shuaibu Danwanka and Samuel Oguche ', 13(1), pp. 1–13.

IHEUKWUMERE, E.O (2022) 'Analysis of the performance challenges affecting state-owned refineries in Nigeria: a systems thinking approach', A thesis submitted in partial fulfilment of the requirements of the Robert Gordon University for the degree of Doctor of Philosophy',

IJSER, (2020 'The environmental implications of abandoned developmental projects in port harcourt

metropolis', International Journal of Scientific & Engineering Research, 11(11), [online] Available from: https://www.ijser.org/researchpaper/THE-ENVIRONMENTAL-IMPLICATIONS-OF-ABANDONED-DEVELOPMENTAL-PROJECTS-IN-PORT-HARCOURT-METROPOLIS.pdf

ILTER, D. ERGEN, E. (2015) 'BIM for building refurbishment and maintenance: Current status and research directions, structural survey', Journal of Building Pathology and Refurbishment, 33(3) pp: 228–256.

INDEED EDITORIAL TEAM (2023) 'Public Goods: Definition, Types and Examples', *Indeed.Com*. Available at: https://www.indeed.com/career-advice/career-development/public-goods.

INGWE, R. AND MBOTO, W. (2012) 'Project Abandonment, Corruption and Recovery of Unspent Budgeted Public Funds in Nigeria', *Revista Romana de Economie*, 34(1), pp. 24–46.

INGWE, R., MBOTO, W. A AND EBONG, E. E. (2012) 'Project Abandonment Corruption and Recovery of unspent Budgeted'.

INSTITUTE FOR GOVERNMENT ANALYSIS (2021) 'Timeline of UK Lockdowns, March 2020 to March 2021', *Institute for Government analysis*, (March 2020), p. 2021.

INTERNATIONAL DEVELOPMENT COMMITTEE (2019) 'Voluntary National Review of progress towards the Sustainable Development Goals', (July), p. 234. Available at: https://sustainabledevelopment.un.org/content/documents/15806Brazil_English.pdf.

INTERNATIONAL TRANSPORT FORUM (2021) 'Developing Strategic Approaches to Infrastructure Planning', Research Report, [online] Available from: https://www.itf-oecd.org/sites/default/files/docs/developing-strategic-infrastructure-planning.pdf

IOL STAFF REPORTER (2018) 'These are the biggest economies in Africa - IMF', *IOL Business Report*, pp. 1–6. Available at: https://www.iol.co.za/business-report/economy/these-are-the-biggest-economies-in-africa-imf-15929339.

IOM (2017) 'Social Cohesion Assessment:Quantitative and Qualitative Assessment of Host-Refugee Cohesion in Three Districts in Turkey', OM's Transition and Recovery Division for IOM/Turkey.

ISMAIL, N.A.A, RAMLI, H. ISMAIL, E.D. ROOSHDI, R.R.R.M. SAHAMIR, S.R. IDRIS, N.H.(2019) 'A review on Green BIM potentials in enhancing the construction Industry Practice', *MATEC Web of Conferences.* [online] 266Available from: https://www.matec-conferences.org/articles/matecconf/pdf/2019/15/matecconf_iconbee2019_01023.pdf

JAHAN, A. KEVIN L. EDWARDS, M. B. (2016) 'Multi-criteria decision-making for materials selection'. doi: 10.1016/B978-0-08-100536-1.00004-7.

JAHAN, A. MUSTAPHA, F. SAPUAN, S.M. ISMAIL M.D.Y & BAHRAMINASAB, M. (2012) 'A framework for weighting of criteria in ranking stage of material selection process', *International Journal of Advanced Manufacturing Technology*, 58(1–4), pp. 411–420. doi: 10.1007/s00170-011-3366-7.

JAMIESON, S. 2004. Likert scales: how to (ab) use them. Med Educ. 38(12):1217–1218

JAMSHED, S. (2014) 'Qualitative research method - interviewing and observation', 5(4), pp. 4–5. doi: 10.4103/0976-0105.141942.

JANMEJOY, G. AND MANJARI, C. (2021) *Energy efficiency in buildings*, *Energy Efficiency Research*. INC. doi: 10.1016/b978-0-12-822989-7.00016-0.

JETEL, V. (2016) 'Coordination of public infrastructure solution for preventing of accidents', *MATEC Web of Conferences*, 93. doi: 10.1051/matecconf/201779303009.

JHANGIANI, R.V. CHIANG, I.A. CUTTLER, C. LEIGHTON, D.C. (2020) 'Research Methods in Psychology', 4th edition, Kwantlen Polytechnic University Surrey, B.C

JIN, R. LI, B. ZHOU, T. WANATOWSKI, D. PIROOZFAR, P. (2017) 'An empirical study of perceptions towards construction and demolition waste recycling and reuse in China', *Resources, Conservation and Recycling*, 126(July), pp. 86–98. doi: 10.1016/j.resconrec.2017.07.034.

JOHANNESSON, P. PERJONS, E. (2014) 'An Introduction to Design Science', Springer International Publishing Switzerland, (eBook), DOI 10.1007/978-3-319-10632-8

JOLAOSO, A.B. NOFIU, M. ABDULFATAH, O. (2013) 'The challenges of sustainable infrastructure development and vision 20:2020: a discourse', African Journal of Social Sciences, 2 (2013), pp. 135-147

JORDAN, K. (2019) 'From finding a niche to circumventing institutional constraints: Examining the links between academics' online networking, institutional roles, and identity-trajectory', *International Review of Research in Open and Distance Learning*, 20(2), pp. 96–112.

JOSTOCK, E. (2020) 'Demolition : plan requirements & common errors, 2020 Digital: Safety, Innovation & Sustainability Conference, NYC Building, [online] Available from: https://www.nyc.gov/assets/buildings/pdf/Demo_Plan_Requirements_Common_Errors.pdf

JUN, S. (2018) 'Bayesian count data modeling for finding technlogical sustainability', Sustainability 2018, 10 (9), 3220. DOI: https://doi.org/10.3390/su10093220

KABIR, G. AND HASIN, M. A. A. (2012) 'Comparative Analysis of Topsis and Fuzzy Topsis for the Evaluation of', *International Journal of Quality Research*, 6(3), pp. 169–185.

KABIR, S. M. S. (2016) 'Ethical Approaches in Research', *Basic Guidelines for Research: An Introductory Approach for All Disciplines*, (July 2016), pp. 519–529.

KABIR, G., SADIQ, R. AND TESFAMARIAM, S. (2014) 'A review of multi-criteria decision-making methods for infrastructure management', *Structure and Infrastructure Engineering*. Taylor & Francis, pp. 1176–1210. doi: 10.1080/15732479.2013.795978.

KAKILLA, C. (2021) 'Strengths and Weaknesses of Semi-Structured Interviews in Qualitative Research: A Critical Essay Charles Kakilla Atlantia Clinical Trials Strengths and Weaknesses of Semi-Structured Interviews in Qualitative Research: A Critical Essay', (June). doi: 10.20944/preprints202106.0491.v1.

KAMARI, A., CORRAO, R. AND KIRKEGAARD, P. H. (2017) 'Sustainability focused decision-making in building renovation', *International Journal of Sustainable Built Environment*, 6(2), pp. 330–350. doi: 10.1016/j.ijsbe.2017.05.001.

KANTERS, J. (2018) 'Design for deconstruction in the design process: State of the art', *Buildings*, 8(11). doi: 10.3390/buildings8110150.

KAPTEIN, M. NASS, C. MARKOPOULOS. P. (2010) ' Powerful and Consistent Analysis of Likert-Type Rating Scales', CHI 2010: 1001 Users, Atlanta, GA, USA, [online] Available from: https://dl.acm.org/doi/pdf/10.1145/1753326.1753686

KARAGEYIK, B.B SAHIN, S. (2017) ' Determination of the Optimal Retention Level Based on Different Measures', Journal of Risk and Financial Management, MDPI, 10 (4), doi:10.3390/jrfm10010004, pp. 1-21

KAREN THEN, JAMES RANKIN, E. A. (2014) 'Focus group research : what is it and how can it be used ?', (March).

KARTHIKEYAN, R., VENKATESAN, K. G. S. AND CHANDRASEKAR, A. (2016) 'A Comparison of Strengths and Weaknesses for Analytical Hierarchy Process', *Journal of Chemical and Pharmaceutical Sciences*, 9(3), pp. 12–15. Available at: www.jchps.com.

KARUNATHILAKE, H. BAKHTAVAR, E. BAKHTAVAR, G. MIAN, H.R. HEWAGE, K. SADIQ, R. (2020) *Decision making for risk management: A multi-criteria perspective*. 1st edn, *Methods in Chemical Process Safety*. 1st edn. Elsevier Inc. doi: 10.1016/bs.mcps.2020.02.004.

KASSAM, A.H. FAREED, O.R (2020) 'Decision Support System on Resources Allocation Problem', 7th International Conference on Logistics and Supply Chain Management [online] Available from: file:///C:/Users/1406849/Downloads/LSCM2020-EnglishProceedingExceptSpringerPapers-172-183.pdf

KASSEM, M. AND AHMED, A. L. (2019) 'Micro BIM Adoption: a Multi-Variable Analysis of Adoption within the UK Architecture Sector', pp. 872–877. doi: 10.3311/ccc2019-120.

KASSEM, M., DAWOOD, N. AND MITCHELL, D. (2012) 'A decision support system for the selection of curtain wall systems at the design development stage', *Construction Management and Economics*, 30(12), pp. 1039–1053. doi: 10.1080/01446193.2012.725940.

KATES, R. W., PARRIS, T. M. AND LEISEROWITZ, A. A. (2016) 'Editorial-What Is Sustainable Development ? Goals, Indicators, Values, and Practice', *Enviroment Science and Policy for Sustainable Development*, pp. 1–13. Available at: http://www.environmentmagazine.org/Editorials/Kates-apr05-full.html.

KAUSHIK, V. AND WALSH, C.A. (2019) ' Pragmatism as a Research Paradigm and Its Implications for Social Work Research', MDPI, Social Sciences, pp. 1-17, 8(2019), [online], Available from: doi:10.3390/socsci8090255

KAZEEM, Y. (2018) 'Nigeria, the new poverty capital of the world', *Quartz Africa*, pp. 2–5.

KEARNEY ET AL., 2019

KELLY, L.M. AND CORDEIRO, M. (2020) ' Three principles of pragmatism for research on organizational processes, Methodological Innovations, SAGE, pp. 1-10 [online], Available from: https://doi.org/10.1177/2059799120937242

KELLE, U. (2014) 'Theorization from data', in Uwe Flick (ed.), The SAGE Handbook of Qualitative Data Analysis. London: Sage, pp. 554

KENNEDY, B.L. (2018) 'The SAGE Handbook of Qualitative Data Collection', Sage Research Methods, SAGE Publications Ltd., DOI: https://doi.org/10.4135/9781526416070

KERIAFE, D.E. AND TIAMIYU, M.A. (2021) ' Decision Maker, Contextual, Task and Information Availability Factors in Information Prioritization for Decision Making in Nigerian Local Government Councils', Journal of Information Science, Systems and Technology, 5(1/2) pp. 1-25. [online], Available from: file:///C:/Users/1406849/Downloads/JISST-51-238-61-FINAL-KERIAFETIAMIYU-DecisionMakerContextualTaskandInformationAvailabilityFactorsinInformationPrioritizationforDecisionMaking.pdf

KHADDAJ, M. AND SROUR., I. (2016) 'Using BIM to Retrofit Existing Buildings.pdf'.

KHAERTDINOVA, A., MALIASHOVA, A. AND GADELSHINA, S. (2021) 'Economic development of the construction industry as a basis for sustainable development of the country', *E3S Web of Conferences*, 274. doi: 10.1051/e3sconf/202127410021.

KHAIRUMAN, K. BARUS, E.S. ZENDRATO, N. BARUS, D.A. SAGALA, J.R. ELHANAFI, A. GINTING, V. (2019) 'The Benefit of Infrastructure Development: An Analysis', *IOP Conference Series: Materials Science and Engineering*, 506(1). doi: 10.1088/1757-899X/506/1/012057.

KHATRI, K.K. (2020) 'Research Paradigm: A Philosophy of Educational Research, International Journal of English Literature and Social Sciences, 5(5), pp' 1435 - 1440, [online] Available from : https://dx.doi.org/10.22161/ijels.55.15

KIM, S. CHOI, M. MHA, H. JOUNG, J.(2013) 'ENVIRONMENTAL IMPACT ASSESSMENT AND ECO-FRIENDLY DECISION-MAKING IN CIVIL STRUCTURES', *Journal of Environmental Management*, 126, pp. 105–112. doi: 10.1016/j.jenvman.2013.03.045.

KIRCHHERR, J., REIKE, D. AND HEKKERT, M. (2017) 'Conceptualizing the circular economy: An analysis of 114 definitions', Resources, Conservation and Recycling, 127(October), pp. 221–232.doi: 10.1016/j.resconrec.2017.09.005.

KISTRUCK, G. M. AND SLADE SHANTZ, A. (2022) 'Research on Grand Challenges: Adopting an Abductive Experimentation Methodology', *Organization Studies*, 43(9), pp. 1479–1505. doi: 10.1177/01708406211044886.

KIVUNJA, C. AND KUYINI, A. B. (2017) 'Understanding and Applying Research Paradigms in Educational Contexts', *International Journal of Higher Education*, 6(5), p. 26. doi: 10.5430/ijhe.v6n5p26.

KLINGENSMITH, J. Z. (2016) 'Pork-barrel spending and state employment levels: Do targeted national expenditures increase state employment in the long run?', *Review of Regional Studies*, 46(3), pp. 257–279. doi: 10.52324/001c.8034.

KLINGENSMITH, J.Z. (2019) 'Political Entrepreneurs and Pork-Barrel Spending', MDPI, Economies, [online]. Available from: http://dx.doi.org/10.3390/economies7010016

KLUMBYTE, E. BLIUDŽIUS, R. MEDINECKIENE, M. FOKAIDES, P.A. (2021) 'An MCDM Model for Sustainable Decision-Making in Municipal Residential Buildings Facilities Management', MDPI, Sustainability, 2021(13) [online]. Available from: https://doi.org/10.3390/su13052820

KONDO, M. C. KEENE, D. HOHL, B. MACDONALD, J.M. BRANAS, C.C. (2015) 'A DIFFERENCE-IN-DIFFERENCES STUDY OF THE EFFECTS OF A NEW ABANDONED BUILDING REMEDIATION STrategy on safety', *PLoS ONE*, 10(7), pp. 1–14. doi: 10.1371/journal.pone.0129582.

KOTU, V. AND DESHPANDE, B. (2019) 'Classification', Sciencedirect, Data Science, Second Edition, , Concept and Practice, DOI: https://doi.org/10.1016/B978-0-12-814761-0.00004-6

KROHLING, R. A. AND PACHECO, A. G. C. (2015) 'A-TOPSIS - An approach based on TOPSIS for ranking evolutionary algorithms', *Procedia Computer Science*, 55(Itqm), pp. 308–317. doi: 10.1016/j.procs.2015.07.054.

KUEPPER, J. (2019) 'What's is a developing country? [online] United State of America: The Balance', Available from: https://www.thebalance.com/what-is-a-developing-country-1978982

KUMAR, R. SINGH, S. BILGA, P.S. SINGH, J.J. SINGH, S. SCUTARU, M. PRUNCU, C.I. (2021) 'Revealing the benefits of entropy weights method for multi-objective optimization in machining operations: A critical review', *Journal of Materials Research and Technology*, 10(4), pp. 1471–1492. doi: 10.1016/j.jmrt.2020.12.114.

LABARAN, Y.H. MATHUR, V.S. MUHAMMAD, S.U. MUSA, A.A. (2022) 'Carbon footprint management: A review of construction industry', Cleaner Engineering and Technology, ELSEVEIR, 2022 (9). DOI : https://doi.org/10.1016/j.clet.2022.100531

LAFORTUNE, G. FULLER, G. SCHMIDT-TRAUB, G. KROLL, C. (2020) 'How is progress towards the sustainable development goals measured? Comparing four approaches for the EU', *Sustainability (Switzerland)*, 12(18). doi: 10.3390/su12187675.

LAPIDUS, A. TOPCHIY, D. KUZMINA, T. BOLSHAKOVA, P. (2022) 'Modelling the Stages of Pre-Project Preparation and Design Development in the Life-Cycle of an Investment and Construction Project', Applied Sciences, 2022 (12), MDPI, DOI: https://doi.org/10.3390/app122312401

LASSEN, A.K. and MERSCHBROCK, 2015. Investigating 'Green BIM in a Norwegian Construction Project:

An Institutional Theory Perspective. *WTH Transaction On The Built Environment.* [online] 149Available from: https://www.witpress.com/Secure/elibrary/papers/BIM15/BIM15042FU1.pdf

LATHAM, A. and LAYTON, J.(2019) ' Social infrastructure and the public life of cities: Studying urban sociality and public spaces', John Wiley and Sons Ltd, Geography Compass, pp -1-15, https://doi.org/10.1111/gec3.12444

LAWRENCE, A. W., IHEBUZOR, N. AND LAWRENCE, D. O. (2020) 'Some Challenges Militating against Developing Countries Achieving SDG 4 on Targets: Nigeria as Case Study', *Modern Economy*, 11(07), pp. 1307–1328. doi: 10.4236/me.2020.117093.

LEAVY, P., 2017. 'Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches'.

LEI, J., HUANG, B. AND HUANG, Y. (2020) *Life cycle thinking for sustainable development in the building industry*, *Life Cycle Sustainability Assessment for Decision-Making: Methodologies and Case Studies*. Elsevier Inc. doi: 10.1016/B978-0-12-818355-7.00006-3.

LEZAK, S. AHEARN, A. MCCONNELL, F. STERNBERG, T. (2019) 'Frameworks for conflict mediation in international infrastructure', Journal of Cleaner Production, ELSEVEIR, Science Direct, 239 (2019), pp-1-14, [online] Available from: https: // doi.org/10.1016/j.jclepro.2019.118099

LINGEGARD, S. OLSSON, J.A. KADEFORS, A. UPPENBERG, S. (2021) ' Sustainable Public Procurement in Large Infrastructure Projects—Policy Implementation for Carbon Emission Reductions', MDPI, Sustainability, 2021 (13), doi.org/10.3390/su132011182

LIU, Y. POULOVÁ, P. PRAŽÁK, P. ULLAH, F. NATHANIEL, P. (2023) **'**Infrastructure development, human development index, and CO_2 emissions in China: A quantile regression approach', *Frontiers in Environmental Science*, 11(January), pp. 1–10. doi: 10.3389/fenvs.2023.1114977.

LIU, Z. LI, P. WANG, F. OSMANI, M. DEMIAN, P. (2022) **'**Building Information Modeling (BIM) Driven Carbon Emission Reduction Research: A 14-Year Bibliometric Analysis', *International Journal of Environmental Research and Public Health*, 19(19). doi: 10.3390/ijerph191912820.

LIU, Z. AND STEPHENS, V. (2019) 'Exploring innovation ecosystem from the perspective of sustainability: Towards a conceptual framework', Journal of Open Innovation: Technology, Market, and Complexity, 5(3). doi: 10.3390/joitmc5030048.

LIU, Q. AND WANG, Z. (2022) 'Green BIM-based study on the green performance of university buildings in northern China', Energy, Sustainability and Society, [online] Available from: https://doi.org/10.1186/s13705-022-00341-9

LIVINGSTON, E. (2023) 'Shell urged not to demolish modernist HQ over carbon emissions fears', The Guardian, [online] Available From: Shell urged not to demolish modernist HQ over carbon emissions fears | Shell | The Guardian

LOCKWOOD, M. (2013) 'The political sustainability of climate policy: The case of the UK Climate Change Act', Global Environmental Change, ELSEVIER, 23 (2013), pp. 1339–1348

LOOSEMORE, M. (2016) 'Social procurement in UK construction projects', *International Journal of Project Management*, 34(2), pp. 133–144. doi: 10.1016/j.ijproman.2015.10.005.

LOPEZ, F.J. LERONES, P.M. LLAMAS, J. GÓMEZ-GARCÍA-BERMEJO, J. ZALAMA, E. (2018) 'A review of Heritage Building Information Modeling (H-BIM)', MDPI, Multimodal Technologies and Interact, 2 (21), doi:10.3390/mti2020021.

LOWE, N. K. (2019) 'What Is a Pilot Study ?', *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, 48(2), pp. 117–118. doi: 10.1016/j.jogn.2019.01.005.

LUANGCHAROENRAT, C. INTRACHOOTO, S. PEANSUPAP, V. SUTTHINARAKORN, W. (2019) **'**Factors

influencing construction waste generation in building construction: Thailand's perspective', *Sustainability (Switzerland)*, 11(13). doi: 10.3390/su11133638.

ŁUCZAK, A. AND JUST, M. (2021) 'Sustainable development of territorial units: MCDM approach with optimal tail selection', *Ecological Modelling*, 457(July). doi: 10.1016/j.ecolmodel.2021.109674.

MAC-BARANGO, D. (2017) 'Construction Project Abandonment: An Appraisal of Causes, Effects and Remedies', *World Journal of Innovation and Modern Technology*, 1(1), pp. 1–10. doi: 10.1017/CBO9781107415324.004.

MACHER, H., LANDES, T. AND GRUSSENMEYER, P. (2017) 'From point clouds to building information models: 3D semi-automatic reconstruction of indoors of existing buildings', *Applied Sciences (Switzerland)*, 7(10), pp. 1–30. doi: 10.3390/app7101030.

MACCHI, M.SAVINO, M. RODA, I. (2020) 'Analysing the support of sustainability within the manufacturing strategy through multiple perspectives of different business functions', J. Clean. Prod., 258, 120771.

MADEDDU, M. AND CLIFFORD, B. (2023) 'The conversion of buildings to housing use: England's permitted development rights in comparative perspective', *Progress in Planning*, 171(June 2022). doi: 10.1016/j.progress.2022.100730.

MANU, P**.** MAHAMADU, A. BOOTH, C. OLOMOLAIYE, P.O. COKER, A. IBRAHIM, A. LAMOND, J. (2019) 'INFRASTRUCTURE PROCUREMENT CAPACITY GAPS IN NIGERIA PUBLIC SECTOR INSTITUTIONS', *ENGINEering, Construction and Architectural Management*, 26(9), pp. 1962–1985. doi: 10.1108/ECAM-11-2017-0240.

MARDANI, A. JUSOH, A. NOR, A.J. KHALIFAH, Z. ZAKWAN, N. VALIPOUR, A. (2015) 'Multiple criteria decision-making techniques and their applications - A review of the literature from 2000 to 2014', *Economic Research-Ekonomska Istrazivanja* , 28(1), pp. 516–571. doi: 10.1080/1331677X.2015.1075139.

MARÍN-GONZÁLEZ, F. SENIOR-NAVEDA, A. CASTRO, M.N. GONZÁLEZ, A.I. CHACÍN, A.J.P (2021) 'Knowledge Network for Sustainable Local Development', Sustainability, MDPI, 13 (1124), https://doi.org/10.3390/su13031124

MARKSON, T. (2022) 'Government to sell e1.5bn worth of civil services offices, Rees-Mogg announces', Cabinet office Government Property Agency, HR Property & Estates, [online], Available from: Government to sell off £1.5bn worth of civil service offices, Rees-Mogg announces.pdf

MARTIN, M. (2023) '10 BEST Decision Making Tools for Business (2023 Update)', [online] Available from: https://www.guru99.com/decision-making-tools.html

MARYROSE, U. MBELEDOGU, N.N. (2014) 'Statistical Analysis of the Implementation of Capital Budget in Anambra State, Nigeria', Journal of Scientific and Engineering Research, 1(2) pp.12-24. [online] Available from: https://oaji.net/articles/2017/4834-1495284307.pdf

MATHEW, M. (2018a). TOPSIS using Excel - MCDM Problem. TOPSIS using Excel - MCDM problem - YouTube .

MATHEW, M. (2018b). TOPSIS - Technique for Order by Similarity to Ideal Solution. https://www.youtube.com/watch?v=kfcN7MuYVeI

MCBRIDE, K., MISNIKOV, Y. AND DRAHEIM, D. (2021) 'Discussing the Foundations for Interpretivist Digital Government Research', *Public Administration and Information Technology*, 38(May), pp. 121–147. doi: 10.1007/978-3-030-92945-9_6.

MCGREGOR, S.L.T. (2019) ' Understanding and Evaluating Research: A Critical Guide', SAGE Research Methods, [online], Available from: https://dx.doi.org/10.4135/9781071802656

MCGUINN, J. FRIES-TERSCH, J. JONES, M. CREPALDI, C. MASSO, M. KADARIK, I. SAMEK LODOVICI, M. DRUFUCA, S. GANCHEVA, M. GENY, B. (2020) 'Social sustainability : Concepts and Brenchmarks',

(April).

MCINTOSH C, ALGERIA T, ORDONEZ G, ZENTENO R (2018) The neighbourhood impact of infrastructure invesment: evidence from urban Mexico. Am Econ J Appl Econ 10:263–286

MCKEOWN, M. JONES, F. FOY, P. WRIGHT, K. PAXTON, T. BLACKMON, M. (2016) 'Looking back, looking forward: Recovery journeys in a high secure hospital', International Journal of Mental Health Nursing 25 (2016), pp.234–242, doi: 10.1111/inm.12204

MENDOZA, M.L.G, REATHEGUI, R.M **(2018) '** Ecuador: Fortalecimiento Institucional y Negociaciones Efectivas en el Escenario Internacional', Ecuador: Institutional Strengthening and Effective Negotiations in the International Arena, RFJ, No. 4, 2018, pp. 245-316,

MHLANGA, S. T. AND LALL, M. (2022) 'Influence of Normalization Techniques on Multi-criteria Decision-making Methods', *Journal of Physics: Conference Series*, 2224(1). doi: 10.1088/1742-6596/2224/1/012076.

MIHAI, F. C. GÜNDOGDU, S. MARKLEY, L.A. OLIVELLI, A. KHAN, F.R. GWINNETT, C. UTBERLET, J. REYNA-BENSUSAN, N. LLANQUILEO-MELGAREJO, P. MEIDIANA, C. ELAGROUDY, S. ISHCHENKO, V. PENNEY, S. LENKIEWICZ, Z. AND MOLINOS-SENANTE, M. (2022) 'Plastic Pollution, Waste Management Issues, and Circular Economy Opportunities in Rural Communities', *Sustainability (Switzerland)*, 14(1). doi: 10.3390/su14010020.

MINZNER, C. (2023) 'Chinas Population Decline Is Not Yet A Crisis Beijings Response Could Make It One.pdf'.

MISSIMER, M. (2015) 'Social sustainability within the framework for strategic sustainable development', Doctoral dissertaion, Department of Strategic Sustainable Development, Blekinge Institute of Technology, Sweden, pp:1-218.

MITCHELL, A. (2018) 'A review of mixed methods, pragmatism and abduction techniques', *Electronic Journal of Business Research Methods*, 16(3), pp. 103–116.

MINISTRY OF DEFENCE (MOD) (2016) 'Understanding and Decision-making', Joint Doctrine Publication 04, Second Edition, [online] Available from : https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/584177/doctrine_uk_understanding_jdp_04.pdf

MOHAJAN, H.K. (2017) 'Two criteria for good measurements in research: Validity and reliability', Annals of Spiru Haret University. Economic Series, 17(4), pp.59-82.

MOHANTY, S.P. HUGHES, D.P. SALATHÉ, M. (2016) 'Using Deep Learning for image -based plant disease detection,' Frontiers in Plant science. (7) doi: 10.3389/fpls.2016.01419

MOHARE, R. (2021) 'Criteria Weight Calculation by Method of Entropy', [online] Available from: https://www.youtube.com/watch?v=TK1yrXYb0c4&list=PL1RK-a9xqPlm8woxq9E7m4g5euzt6NXeS&index=14

MINISTRY OF JUSTICE (MOJ) (2019) 'Sustainable procurement policy', *Journal of Sustainable procurement*, 2(December 2011), pp. 1–10.

MOON, K. CVITANOVIC, C. BLACKMAN, D.A. SCALES, I.R. BROWNE, N.K. (2021) **'**FIVE QUESTIONS TO UNDERSTAND EPISTEMOLOGY AND ITS INFLUENCE ON INTEGRATIVE MARINE Research', *Frontiers in Marine Science*, 8(March), pp. 1–9. doi: 10.3389/fmars.2021.574158.

MORCKEL, V. (2014) 'Predicting abandoned housing: does the operational definition of abandonment matter?', *Community Development*, 45(2), pp. 121–133. doi: 10.1080/15575330.2014.892019.

MOORE, D.R. CHENG, M. DAINTY, A.R.J. (2002) 'Competence, competency and competencies: performance assessment in organisations', EmeraldInsight, 51(6), [online] Available from: https://doi.org/10.1108/00438020210441876

MORGAN, D. L. AND NICA, A. (2020) 'Iterative Thematic Inquiry: A New Method for Analyzing Qualitative Data', *International Journal of Qualitative Methods*, 19, pp. 1–11. doi: 10.1177/1609406920955118.

MORGAN, O., DOMINIC, I. E. AND OKECHUKWU, E. O. (2018) 'Poor maintenance of public buildings in nigeria 1 Olokpo Morgan I. 2 Ealefoh Dominic E. 3 Onwuka Okechukwu', 10(1), pp. 40–48.

MOTA, P., CAMPOS, A. R. AND NEVES-SILVA, R. (2013) 'First Look at MCDM: Choosing a Decision Method', *Advances in Smart Systems Research*, 3(2), pp. 25–30.

MOUSAVI, S.M. ASHTIANI, B. HOSSEINI, S.M. (2022) 'Comparison of statistical and MCDM approaches for flood susceptibility mapping in northern Iran', Journal of Hydrology, ELSEVIER, 612,

MOYO, B. AND RAVHUHALI, K. E. (2022) 'Abandoned Croplands: Drivers and Secondary Succession Trajectories under Livestock Grazing in Communal Areas of South Africa', *Sustainability (Switzerland)*, 14(10), pp. 1–14. doi: 10.3390/su14106168.

MUKHERJEE, S. ASTHANA, S. UKPONU, W. IHUEZE, A.C. GOBIR, I.B. PHELAN, A.L. STANDLEY, C.J. (2023) 'National and subnational governance and decision-making processes during the COVID-19 pandemic in Nigeria: an empirical analysis', BMJ Global Health, pp: 1-12, DOI : (http://dx.doi.org/10.1136/bmjgh-2023-012965).

MUKHTAR, N. AND SAUD, M. S. B. (2019) 'The Need for Incorporating Sustainability Thinking into Higher National Diploma Electrical/Electronic Engineering Curriculum in Nigeria', *Asian Social Science*, 15(8), p. 113. doi: 10.5539/ass.v15n8p113.

MULDERS, A. VALDES, O.R. RIC´OS, F.P. AHO, P. MAR´IN, B. VOS, T.E.J. (2022) 'State Model Inference Through the GUI Using Run-Time Test Generation', Springer Nature Switzerland, RCIS 2022, LNBIP 446, pp. 546–563, [online] Available from: https://doi.org/10.1007/978-3-031-05760-1_32

MUÑOZ-PASCUAL, L., CURADO, C. AND GALENDE, J. (2019) 'The triple bottom line on sustainable product innovation performance in SMEs: A mixed methods approach', *Sustainability (Switzerland)*, 11(6). doi: 10.3390/su11061689.

MUNYASYA, B. M. AND CHILESHE, N. (2018) 'Towards Sustainable Infrastructure Development: Drivers, barriers, strategies, and coping mechanisms', *Sustainability (Switzerland)*, 10(12), pp. 1–18. doi: 10.3390/su10124341.

MUZENDA, A. (2018) 'Abandoned Buildings in Lagos ', (December 1991), pp. 1–6.

MYLEVAGANAM, S., CHUI, T. F. M. AND HU, J. (2015) 'An Interface to Model 3D Hydrological Process of a Soak-Away Rain Garden', Computational Water, Energy, and Environmental Engineering, 04(02), pp. 5–17. doi: 10.4236/cweee.2015.42002.

'Nigeria and abandoned projects.pdf' (no date).

NAEINI, M. MOHAMMADINIA, A. ARULRAJAH, A. HORPIBULSUK, S. (2021) **'S**tress-dilatancy responses of recovered plastics and demolition waste blends as a construction material', *Construction and Building Materials*, 297, p. 123762. doi: 10.1016/j.conbuildmat.2021.123762.

NAESS, P. (2018) 'Validating explanatory qualitative research: Enhancing the interpretation of interviews in urban planning and transportation research'. Applied Mobilities.

NAIR, R.P (2008) 'Software Testing : Software Life Cycle Models',

NAJJAR, N.M. JARBI, N. (2016) ' Gold Plating of the Project Scope Identification and Solution', Journal of Multidisciplinary Engineering Science and Technology (JMEST), 3(6), pp. 5028-5032

NATIONAL VOLUNTARY REVIEW (NVR) (2020) 'Implementation of SDGs: A National Voluntary Review' (NVR) on Sustainable Development Goals: Main Messages', Nigeria's 2020 Voluntary National Review (NVR), p. 3.

NGORAN, S. D., XUE, X. Z. AND WESSEH, P. K. (2016) 'Signatures of water resources consumption on sustainable economic growth in Sub-Saharan African countries', *International Journal of Sustainable Built Environment*, 5(1), pp. 114–122. doi: 10.1016/j.ijsbe.2016.04.002.

NGUYEN, T. Q. T. (2015) 'Conducting semi-structured interviews with the vietnamese', Qualitative Research Journal, 15(1), 35–46. https://doi.org/10.1108/QRJ-04-2014-0012

NATIONAL INFRASTRUCTURE COMMISSION (NIC) (2018) 'National Infrastructure Assessment', [online] Available from : https://nic.org.uk/app/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible-1.pdf

NIJAKI, L. K. AND WORREL, G. (2012) 'Procurement for sustainable local economic development', *International Journal of Public Sector Management*, 25(2), pp. 133–153. doi: 10.1108/09513551211223785.

NIZAMUTDINOV, T. SULEYMANOV, A. MORGUN, E. YAKKONEN, K. ABAKUMOV, E. (2022) 'Soils and olericultural practices in circumpolar region of Russia at present and in the past', *Frontiers in Sustainable Food Systems*, 6. doi: 10.3389/fsufs.2022.1032058.

NNAMSEH, M. P. AND AKPAN, S. S. (2021) Strategic implications and risks of abandoned infrastructural projects on economic development in akwa ibom state, nigeria 'International Journal of Economics, Commerce and Management United Kingdom', IX(1), pp. 127–142. Available at: http://ijecm.co.uk/.

NOBLE, H. AND MITCHELL, G. (2016) 'What is grounded theory ?', 19(2), pp. 34–35.

NOGUEIRA, E., GOMES, S. AND LOPES, J. M. (2023) 'Triple Bottom Line, Sustainability, and Economic Development: What Binds Them Together? A Bibliometric Approach', *Sustainability (Switzerland)*, 15(8). doi: 10.3390/su15086706.

NOWELL, L. S**.** NORRIS, J.M. WHITE, D.E. MOULES, N.J. (2017) 'Thematic Analysis: Striving to Meet the Trustworthiness Criteria', *International Journal of Qualitative Methods*, 16(1), pp. 1–13. doi: 10.1177/1609406917733847.

NOWELL, L. (2015) 'Pragmatism and integrated knowledge translation: exploring the compatabilities and tensions', NursingOpen, John Wiley & Sons Ltd. [online] Available from: doi: 10.1002/nop2.30

NOWOGONSKA, B. AND MIELCZAREK, M. (2021) 'Renovation management method in neglected buildings', *Sustainability (Switzerland)*, 13(2), pp. 1–20. doi: 10.3390/su13020929.

NSIAH-ASAMOAH, P. E. (2019) 'Assessment of Causes, Effects and Solutions to Abandoned Building Projects in Ghana Prince', *Paripex - Indian Journal of Reserach*, 5(10), pp. 622–624. doi: 10.15373/22501991.

NWANEKEZIE, O. AND NWANGUMA, W. (2019) 'A Study of Causes of Uncompleted / Abandoned Building Projects and Its Effect on Real Property in Uyo Metropolis ', 9(2), pp. 45–50. doi: 10.5923/j.arch.20190902.03.

NWANNEKANMA, B. AND GBONEGUN, V. 2019 (2019) 'A nation mired in waste as multi-billion naira properties rot away — Property — The Guardian Nigeria News – Nigeria and World News'.

NYUMBA, T.O. WILSON, K. DERRICK, C.J. MUKHERJEE, N. (2018) 'The use of focus group discussion methodology: Insights from two decades of application in conservation', *Methods in Ecology and Evolution*, 9(1), pp. 20–32. doi: 10.1111/2041-210X.12860.

OBI, L. AWUZIE, B. OBI, C. OMOTAYO, T.S. OKE, A. OSOBAJO, O. (2021) 'Bim for deconstruction: An interpretive structural model of factors influencing implementation', *Buildings*, 11(6). doi: 10.3390/buildings11060227.

OBILOR, E.I. (2023) 'Convenience and Purposive Sampling Techniques: Are they the Same?', International Journal of Innovative Social & Science Education Research, SEAHI PUBLICATIONS 11(1) pp.1-7, [online] Available from: http://www.seahipaj.org/.

ODEYINKA, O. F. OLUWAJI, O.A. OMOKOLADE. F.D. (2018) 'An Assessment of the Causes and Effects of Abandonment of Road Construction Projects in Osun State Nigeria', The Pacific Journal of Science and Technology-187. Available at: http://www.akamaiuniversity.us/PJST.htm. 19(2):187-195.

ODOH, M. AND E, I. C. (2014) 'Research Designs , Survey and Case Study', 4(6), pp. 16–22.

ODU, G. O. (2019) 'Weighting methods for multi-criteria decision making technique', *Journal of Applied Sciences and Environmental Management*, 23(8), p. 1449. doi: 10.4314/jasem.v23i8.7.

ODUNJO AND OMOLOLA, O. (2013) 'Why Nigeria is not yet Sustainably Developed', *APCBEE Procedia*, 5, pp. 383–387. doi: 10.1016/j.apcbee.2013.05.066.

ODUTOLA, A. AND ADENIRAN, Y. (2017) '10 states abandon N3trn projects – Investigation - The Point'.

OECD (2015) 'Fostering Investment in Infrastructure - Lessons learned from OECD Investment Policy Reviews', (January), p. 57.

OECD (2021a) 'Beyond prototypes: Enabling innovation in technology-enhanced learning', (October 2014). doi: 10.13140/2.1.1026.8163.

OECD (2021b) 'Building Resilience: New Strategies for Strengthening Infrastructure Resilience and Maintenance', *OECD Public Governance Policy Papers*, (05), pp. 14–16.

OECD/ACET. (2020) 'Quality Infrastructure in 21st Century Africa: Prioritising, Accelerating and Scaling up in the Context of PIDA (2021-30). ', *OECD Publishing.* Available at: https://www.oecd.org/dev/Africa-Quality-infrastructure-21st-century.pdf.

OGBONNAYA,C. ABEYKOON, C. DAMO, U.M. TURAN, A. (2019) 'The current and emerging renewable energy technologies for power generation in Nigeria: A review', Thermal Science and Engineering Progress, ELSEVIER, 13 (2019), https://doi.org/10.1016/j.tsep.2019.100390

OGOLO, J. (2019) 'Nigerian journal of engineering management , vol 11 , survey and case study by by department of business administration niger delta', (December).

OGUNBAYO, B.F. AIGBAVBOA, C.O. THWALA, W.D. AKINRADEWO, O.I EDWARDS, D. (2022) Validating elements of organisational maintenance policy for maintenance management of public buildings in Nigeria, Emerald Insight, Journal of Quality in Maintenance Engineering, Emerald Publishing Limited. 1355-2511, DOI 10.1108/JQME-05-2021-0039

OGUNNUSI., SALMAN, H., LAING, R. AND OMOTAYO, T. (2022) 'The 5Rs for waste management of abandoned infrastructure in Nigeria .', 2022(September).

OGUNNUSI, M. (2015) 'Public Private Partnership in Public Assets Procurement ':, pp. 1–118.

OGUNNUSI, M., SALMAN, H. AND LAING, R. (2021) 'Infrastructure Development and Abandonment-Nigerian Context'.

OGUNNUSI, M., SALMAN, H. AND LAING, R. (2021D) 'Infrastructure development and abandonment', *Proceedings of International Structural Engineering and Construction*, 8(1), p. INF-08-1-INF-08-6. doi: 10.14455/ISEC.2021.8(1).INF-08.

OGUNNUSI, M., SALMAN, H. AND LAING, R. (2023) 'TOPSIS analysis for sustainable redevelopment potential of abandoned infrastructure in Nigeria', *Built Environment Project and Asset Management*, 13(1), pp. 73–88. doi: 10.1108/BEPAM-11-2021-0140.

OGUZTIMUR, S. (2015) 'Why fuzzy analytic hierarchy process approach for transport problems?', (September). Available at: https://www.researchgate.net/publication/254457609.

OJO, A. E. (2022) 'Sustainable infrastructure for Nigeria's sustainable economic development: whither transportation or electric power supply?', *Journal of Mega Infrastructure & Sustainable Development*, 2(3), pp. 248–261. doi: 10.1080/24724718.2021.2012364.

OJOKOH, B. AND AFOLAYAN, A. H. (2018) 'Analysis of Multi-Criteria Decision Making Methods for', (September 2021).

OKAFOR, F. O., OSADEBE, N. N. AND SYLVESTER, I. J. (2018) 'Abandoned projects-implication on the strength of exposed steel and concrete in the Southern region of Nigeria', *Nigerian Journal of Technology*, 37(3), p. 562. doi: 10.4314/njt.v37i3.1.

OKAKPU, A. GHAFFARIANHOSEINI, A. TOOKEY, J. HAAR, J. REHMAN, A. (2018) 'A PROPOSED FRAMEWORK TO INVESTIGATE EFFECTIVE BIM ADOPTION FOR REFURBISHMENT OF BUILDING Projects', 8628. doi: 10.1080/00038628.2018.1522585.

OKEREKE, O. C. (2016) 'Development of Infrastructure to stimulate the Nigerian economy and case for a Nigerian National Programme Management Office (PMO)', V(Iv), pp. 1–11.

OKEREKE, O. C. (2017) 'Causes of failure and abandonment of projects and project deliverables in Africa', *PM World Journal*, VI(I), pp. 1–16.

OLANREWAJU, O. (2021) 'Building Information Modelling and Project-Lifecycle', [online]. Available from : https://encyclopedia.pub/entry/13241, doi: 10.3390/su13168887

OGUNKAN, D. V. (2022) 'Achieving sustainable environmental governance in Nigeria: A review for policy consideration', *Urban Governance*, pp. 212–220. doi: 10.1016/j.ugj.2022.04.004.

OJO (2021) 'Sustainable infrastructure for Nigeria's sustainable economic development: whither transportation or electric power supply?', Journal of Mega Infrastructure & Sustainable Development, 2:3, 248-261, DOI: 10.1080/24724718.2021.2012364

OLALUSI, O. AND OTUNOLA, A. (2012) 'Abandonment of building projects in Nigeria- A review of causes and solutions', *Politics*, 50(20), pp. 24–26.

OLANIPEKUN, A. O., AWODELE, O. A. AND AJE, I. O. (2014) 'Contextualising Sustainable Infrastructure Development in', *FUTY Journal of the Environment*, 8(1), pp. 80–92.

OLATUNBOSUN, A. J., OLASODE, O. S. AND ADENIRAN, I. G. (2013) 'Infrastructural Development and Its Effect on Economic Growth : the Nigerian Perspective', *European Scientific Journal*, 9(31), pp. 431–452.

OLAWUMI, T. O. (2020) 'Development of a BIM-enabled and cloud-based sustainability assessment system for buildings in Sub-Saharan Africa: The case of Nigeria'. *Thesis*. The Hong Kong Polytechnic University'.

OLUMIDE ODEYINKA, O. O. F. O. (2018) 'An Assessment of the Causes and Effects of Abandonment of Road Construction Projects in Osun State Nigeria', The Pacific Journal of Science and Technology, 19(2), pp. 187–195.

OMOTAYO, T., AWUZIE, B., EGBELAKIN, T., OBI, L., OGUNNUSI, M. (2020) 'AHP-systems thinking analyses for Kaizen costing implementation in the construction industry . AHP-Systems Thinking Analyses for Kaizen Costing Implementation in the Construction Industry', 10(12), pp. 0–25. doi: 10.3390/buildings10120230.

OMOTAYO, T**.** AWUZIE, B. EGBELAKIN, T. OBI, L. OGUNNUSI, M. (2020**) '**AHP-systems thinking analyses for kaizen costing implementation in the construction industry', *Buildings*, 10(12), pp. 1–24. doi: 10.3390/buildings10120230.

OMOTAYO, T.S. KULATUNGA, U. BJEIRMI, B. (2018) 'Critical success factors for Kaizen implementation in the Nigerian construction industry', International Journal of Productivity and Performance Management, Emeraldinsight, Emerald Publishing Limited. [online], Available from: OMOTAYO 2018

Critical success factors for Kaizen.pdf

ONAIKAN, T. (2013). 'Response to question on abandoned projects in Nigeria', 5th Annual Distinguished Lecture Series organized by the Nigerian Institute of Quantity Surveyors, Lagos chapter, NIIT, V/I, Lagos.

O'REILLY, M., KIYIMBA, N. AND DREWETT, A. (2021) 'Mixing qualitative methods versus methodologies: A critical reflection on communication and power in inpatient care', *Counselling and Psychotherapy Research*, 21(1), pp. 66–76. doi: 10.1002/capr.12365.

ORMSTON, R. SPENCER, L. BARNARD, M. & SNAPE, D. (2014) 'The foundations of qualitative research' In J. Ritchie, J. Lewis, C. Nicholls & R. Ormston (Eds.), Qualitative Research Practice: A Guide for Social Science Students and Researchers (pp. 1-25). Los Angeles: Sage.

OSOBAJO, O.A. (2017) 'Enhancing B2Com relationship quality: A research study investigating the oil producing company to host community relationship in the Niger Delta Region of Nigeria', A thesis submitted in partial fulfilment of the requirements of the Robert Gordon University for the degree of Doctor of Philosophy'

OYEDELE, O. A. (2012) 'The Challenges of Infrastructure Development in Democratic Governance', *Journal of Business Administration and Management Sciences Research*, 2(May 2012), pp. 6–10. Available at: Fulmer, Jeffrey (2009).

OYELEKE, S.(2022), '10 abandoned projects in Nigeria you should know about', Punch Nigeria Limited. [Online]. Available from : https://punchng.com/10-abandoned-projects-in-nigeria-you-should-know-about/

OYEWOBI, L. O., IJA, M. I. AND JIMOH, R. A. (2017) 'Achieving Sustainable Procurement Practices in the Nigerian Construction Industry : Examining Potential Barriers and Strategies'.

OYEWOBI, L. O. AND JIMOH, R. A. (2022) 'Barriers to Adoption of Sustainable Procurement in the Nigerian Public Construction Sector', *Sustainability (Switzerland)*, 14(22), pp. 1–14. doi: 10.3390/su142214832.

OYOYO, I. (2021), 'Abuja now home to abandoned, White Elephant Projects', AllAfrica, [online] Available from: https://allafrica.com/stories/202110200021.html

PALLANT, J. (2016) SPSS Survival Manual: a step by step guide to data analysis using IBM SPSS, 6th Edition.

PAMUČAR, D., STEVIĆ, Ž. AND SREMAC, S. (2018) 'A new model for determiningweight coefficients of criteria in MCDM models: Full Consistency Method (FUCOM)', *Symmetry*, 10(9), pp. 1–22. doi: 10.3390/sym10090393.

PANDI, V. (2017) 'Examining effects of "Negative Freight" pricing strategy on NVOCC's operating in the Middle East – South Asia trade route', Master Thesis, International University of Applied Sciences Bad Honnef · Bonn.

PANTINI, S. AND RIGAMONTI, L. (2020) 'Is selective demolition always a sustainable choice?', *Waste Management*, 103, pp. 169–176. doi: 10.1016/j.wasman.2019.12.033.

PARK, Y.S. KONGE, L. ARTINO, A.R. (2020) 'The Positivism Paradigm of Research', journal of the Association of American Medical Colleges, 95 (5), http://network.bepress.com/hgg/discipline/648?utm_source=hsrc.himmelfarb.gwu.edu%2Fsmhs_hs_facpubs%2F76&utm_medium=PDF&utm_campaign=PDFCoverPages [online], Available from: http://dx.doi.org/10.1097/ACM.0000000000003093

PATTON, M.Q. (1999) 'Enhancing the quality and credibility of qualitative analysis', Health services research, 34(5 Pt 2), p.1189.

PAVLOVSKIS, M., ANTUCHEVICIENE, J. AND MIGILINSKAS, D. (2017) 'Assessment of Buildings Redevelopment Possibilities using MCDM and BIM Techniques', *Procedia Engineering*, 172, pp. 846–850. doi: 10.1016/j.proeng.2017.02.083.

PEHRSON, S. STAMBULOVA, N.B. OLSSON, K. (2017) 'Revisiting the empirical model 'Phases in the junior-to-senior transition of Swedish ice hockey players': External validation through focus groups and interviews. International Journal of Sports Science & Coaching, 12(6), pp.747-761.

PERIASAMY, P. (2010) 'A textbook of financial cost and management accounting', Himalaya Publishing House, Revised Edition,

PETKOVIĆ-GROZDANOVIĆA, STOILJKOVIĆ, B. KEKOVIĆ, A. MURGUL, V. (2016) 'The Possibilities for Conversion and Adaptive Reuse of Industrial Facilities into Residential Dwellings', 15th International scientific conference "Underground Urbanisation as a Prerequisite for Sustainable Development", *Procedia Engineering*, ELSEVEIR, ScienceDirect, 165, pp. 1836–1844. doi: 10.1016/j.proeng.2016.11.931.

PHAN, T.T.H. TRAN, H.X. LE. T.T. NGUYEN, N. PERVAN, S. AND TRAN, M.D. (2020) 'The Relationship between Sustainable Development Practices and Financial Performance: A Case Study of Textile Firms in Vietnam', Sustainability, MDPI, 2020(15) pp:1-21, DOI: http://dx.doi.org/10.3390/su12155930

PHILIP, A., EBENEZER, R. AND KEHINDE, O. (2012) 'Failure and Collapse of Buildings in Nigeria : the Role of Professionals and Other Participants in the Building Industry', *Interdisplinary Journal of Contemporary Research in Bussiness*, 4(6), pp. 1267–1272.

PICKARD, J.HAMMOND, G. (2022) 'UK ministers plan to sell state buildings worth E1.5bn', The financial Times Limited, [online], Available from: UK Ministers plan to sell state buildings worth 1 5 bn.pdf

PILL, S. (2017) ' What are physical education teachers being told about how to teach sport? An exploratory analysis of sport teaching in physical education', International Journal of Learning in Social Contexts, Special issue: 2017 30th ACHPER International Conference.

PINQUART, M. 2021 ' Experimental Studies and Observational Studies', Psychology, Philipps University, Marburg, Germany

PROJECT MANAGEMENT INSTITUTE, and PROJECT MANAGEMENT INSTITUTE, 2017 'A guide to the project management body of knowledge (PMBOK guide)', Sixth ed. Newtown Square, PA: Project Management Institute.

POGORELSKIY, S. AND ALAVA, D. (2018) 'Building Information Modelling: Present realities and Future possibilities', *International Journal of Engineering and Management Sciences*, 3(4), pp. 377–394. doi: 10.21791/ijems.2018.4.32.

PONOMARENKO, T. NEVSKAYA, M. MARININA, O.(2020) 'An Assessment of the Applicability of Sustainability Measurement Tools to Resource-Based Economies of the Commonwealth of Independent States', Sustainability, MDPI, 12, 5582, doi:10.3390/su12145582

PONTO, J. (2015) 'Understanding and Evaluating Survey Research'.

PORRAS-AMORES, C. GARCIA, M. SÁEZ, P.V. MERINO, M.D.R. VITIELO, V. (2021) 'Assessing the energy efficiency potential of recycled materials with construction and demolition waste: A Spanish case study', *Applied Sciences (Switzerland)*, 11(17). doi: 10.3390/app11177809.

PRAMANIK, P. K. D. BISWAS, S. PAL, S. MARINKOVIC, D. CHOUDHURY, P. (2021) **'**A comparative analysis of multi-criteria decision-making methods for resource selection in mobile crowd computing', *Symmetry*, 13(9), pp. 1–51. doi: 10.3390/sym13091713.

PRANAS ŽUKAUSKAS, J. V. AND R. A. (2018) 'Philosophy and Paradigm of Scientific Research', *Intech*, 11(tourism), p. 13. Available at: https://www.intechopen.com/books/advanced-biometric-technologies/liveness-detection-in-biometrics.

PRIEST, I. (2019) 'Battersea Power Station revamp opens up electric avenues.pdf'.

PRINDLE, W. CHOATE, A. DIX, B. (2018) 'How to build a resilient and sustainable infrastructure', [online] Available from: https://www.icf.com/insights/disaster-management/building-sustainable-infrastructure

PROAG, V. (2021) In*frastructure Planning and Management: An Integrated Approach*, *Infrastructure Planning and Management: An Integrated Approach*. doi: 10.1007/978-3-030-48559-7.

PUENTES, R. (2015) 'Why Infrastructure Matters: Rotten Roads, Bum Economy', *Brookings*.

PUJIATI, A. SETIAJI, K. PURASANI, H.N. FARLIANA, N.(2019) 'Integration of Environmental Economics to Build Economic Behaviors', *E3S Web of Conferences*, 125(201 9). doi: 10.1051/e3sconf/201912502009.

PURVIS, B. Y. M. R. (2018) 'Three pillars of sustainability: in search of conceptual origins', *Environmental Conservation*. doi: 10.1017/S0376892900011449.

QU, W. LI, J. SONG, W. LI, X. ZHAO, Y. DONG, H. WANG, Y. ZHAO, Q. (2022) 'Entropy-Weight-Method-Based Integrated Models for Short-Term Intersection Traffic Flow Prediction', *Entropy*, 24(7), pp. 1–15. doi: 10.3390/e24070849.

QUICENO, G. ÁLVAREZ, C. ÁVILA, R. FERNÁNDEZ, Ó. FRANCO, C.J. KUNC, M.DYNER, I. (2019) 'Scenario analysis for strategy design: A case study of the Colombian electricity industry', Energy Strateg. Rev. 2019, 23, 57–68.

RAHIM, R. SUPIYANDI, S. SIAHAAN1, A.P.U. LISTYORINI, T. UTOMO, A.P. TRIYANTO, W.A. IRAWAN, Y. AISYAH, S. KHAIRANI, M. SUNDARI6, S. KHAIRUNNISA, K. (2018) **'**TOPSIS Method Application for Decision Support System in Internal Control for Selecting Best Employees', *Journal of Physics: Conference Series*, 1028(1). doi: 10.1088/1742-6596/1028/1/012052.

RAHMAN, A. AND MUKTADIR, M. G. (2021) 'SPSS: An Imperative Quantitative Data Analysis Tool for Social Science Research', *International Journal of Research and Innovation in Social Science*, 05(10), pp. 300–302. doi: 10.47772/ijriss.2021.51012.

RAHMAN, F. A. (2014) 'Reduce , Reuse , Recycle : Alternatives for Waste Management', *NM* 12 *State University*, pp. 1–4.

RAJ, P. P. E. (2016) 'Postmodern thought in ihab hassan', 2(4), pp. 104–109.

RAJSHREE (2012) 'Themes of Postmodern Education', International Journal of Scientific and Research Publications, 2 (12), [online], Available from : www.ijsrp.org

RAKAUSKIENE, O. G. AND KOZLOVSKIJ, V. (2014) 'Overview of EU Economic Cohesion Process Performance for New Member States', *Procedia - Social and Behavioral Sciences*, 110, pp. 284–292. doi: 10.1016/j.sbspro.2013.12.872.

RASHID, Y., RASHID, A. AND WARRAICH, M. A. WASEEM, A. (2019) 'Case Study Method : A Step-by-Step Guide for Business Researchers', International Journal of Qualitative Methods, 18, pp. 1–13. doi: 10.1177/1609406919862424.

RATHI, S. AND KHANDVE, P. (2014) 'Demolition of Buildings **?** An Overview', *International Journal of Advance Engineering and Research Development*, 1(06). doi: 10.21090/ijaerd.010643.

RAZA, M. (2017) 'BIM for Existing Buildings: A Study of Terrestrial Laser Scanning and Conventional Measurement Technique', pp. 1–110.

REGNAULT, A., WILLGOSS, T. AND BARBIC, S. (2018) 'Towards the use of mixed methods inquiry as best practice in health outcomes research', *Journal of Patient-Reported Outcomes*, 2, pp. 2–5. doi: 10.1186/s41687-018-0043-8.

RAMESH, R. ZIONTS, S. (2013) ' Multiple Criteria Decision Making', University at Buffalo, The State University of New York, Buffalo, NY, USA, pp. 1007-1013

REIKE, D., VERMEULEN, W. J. V. AND WITJES, S. (2018) 'The circular economy: New or Refurbished as CE 3.0? — Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options', *Resources, Conservation and Recycling*, 135(August 2017), pp. 246–264. doi: 10.1016/j.resconrec.2017.08.027.

RELIANCE FOUNDRY (2023) 'What is Infrastructure? From shovels-in-the-ground to digital networks', [online] Available from: https://www.reliance-foundry.com/blog/what-is-infrastructure#:~:text=Examples%20of%20private%20infrastructure&text=For%20example%3A,in%20port%20and%20dock%20facilities

REMOY, H. AND VAN DER VOORDT, T. (2014) 'Adaptive reuse of office buildings into housing: Opportunities and risks', *Building Research and Information*, 42(3), pp. 381–390. doi: 10.1080/09613218.2014.865922.

REVILLA, M. A., SARIS, W. E. AND KROSNICK, J. A. (2014) 'Choosing the Number of Categories in Agree-Disagree Scales', *Sociological Methods and Research*, 43(1), pp. 73–97. doi: 10.1177/0049124113509605.

RICKARD, N. ARJMAND, H. BAKKER, D. SEABROOK, E. (2016) 'Development of a mobile phone app to support self-monitoring of emotional well-being: A mental health digital innovation', *JMIR Mental Health*, 3(4). doi: 10.2196/mental.6202.

RICHARDSON, J.V. (2013) 'The information economy of Turkmenistan: A seven-year update', International Federation of Library Associations and Institutions, SAGE Publication, 39 (3) pp. 243–250, DOI: 10.1177/0340035213498836

RIFFEL, A. (2020) 'Social and Cultural relevance of aspects of Indigenous knowledge systems (IKS), Meteorological Literacy and Meteorological Science Conceptions,' A thesis submitted in fulfilment of the requirements for the degree : Ph . D (Doctor of Philosophy), APRIL 2020 School of Science and Mathematics Education (SSME) Faculty of Education University of the Western Cape , Republic of South Africa', (April). doi: 10.13140/RG.2.2.28421.47846.

RIMANTHO, D. RAHMAN, T.A. CAHYADI, B. HERNAWATI, T.S. (2016) ' Application of six sigma and AHP in analysis of variable lead time calibration process instrumentation', AIP Conference Proceedings, The 1st International Conference on Mathematics, Science, and Computer Science (ICMSC) 2016, America Institute of Physics, doi: 10.1063/1.4975969

ROBERT, J.M. (2014) ' Critical Realism, Dialectics, and Qualitative Research Methods', Journal for the Theory of Social Behaviour, 44(1), [online], Available from: 1–23. https://doi.org/10.1111/jtsb.12056

ROBINSON, R.S. (2014) 'Purposive sampling', Justice and Social Inquiry, Arizona State University, Tempe, AZ, USA

ROBINSON, M.A. (2016) 'Quantitative Research Principles and Methods for Human-Focused Research in Engineering Design', Chapter 3, Experimental Design Research, P. Cash et al. (eds.), Springer International Publishing Switzerland, DOI 10.1007/978-3-319-33781-4_3

RODRIGUEZ, C. (2022) 'The richest countries in the world: Tiny Luxembourg at the top', *Forbes*, [online], Available at : The Richest Countries In The World: Tiny Luxembourg At The Top (forbes.com)

ROHMATULLOH, R. AND WINARNI, S. (2014) 'TOPSIS Method for Determining The Priority of Strategic Training Program', *International Journal on Advanced Science, Engineering and Information Technology*, 4(2), p. 67. doi: 10.18517/ijaseit.4.2.370.

ROLLER, R., EGLSEER, D. AND WIRNSBERGER, G. H. (2016) 'Nursing home professionals opinions on determinants of malnutrition – A NURSING HOME PROFESSIONALS OPINIONS ON DETERMINANTS OF MALNUTRITION – A QUALITATIVE STUDY', (February). doi: 10.14283/jnhrs.2016.4.

ROMO-OROZCO, J. M. Contreras-Jiménez, J.C. Corona-Armenta, J.R. Morales-Mendoza,L.F. (2022) 'A methodological approach to evaluate structural building projects through the Environmental Economic Index', *Clean Technologies and Environmental Policy*, 24(3), pp. 901–918. doi: 10.1007/s10098-021-02230-9.

RONI, S.M. AND DJAJADIKERTA, H.G (2021) ' Data Analysis with SPSS for Survey-based Research', Springer,

ROSENZWEIG, E. (2015) 'UX Thinking', *Successful User Experience: Strategies and Roadmaps*, pp. 41–67. doi: 10.1016/b978-0-12-800985-7.00003-x.

ROSZKOWSKA, E. (2011) 'Multi-Criteria Decision Making Models By Applying the Topsis Method To Crisp and Interval Data', *International Scientific Journal*, 6(1), pp. 200–230.

ROWLEY, J. (2014) 'Designing and using research questionnaires', *Management Research Review*, 37(3), pp. 308–330. doi: 10.1108/MRR-02-2013-0027.

ROY, J., ADHIKARY, K. AND KAR, S. (2019) 'Credibilistic TOPSIS Model for Evaluation and Selection of Municipal Solid Waste Disposal Methods', *Advances in Waste Management*, pp. 243–261. doi: 10.1007/978-981-13-0215-2_17.

ROYAL INSTITUTION OF CHARTERED SURVEYORS (RICS, 2014) ' Tendering strategies: RICS guidance note, UK', 1st edition, [online] Available from: file:///C:/Users/1406849/Downloads/tendering_strategies_1st_edition_rics.pdf

RUPARATHNA, R. AND HEWAGE, K. (2015) 'Review of contemporary construction procurement practices', *Journal of Management in Engineering*, 31(3), pp. 28–29. doi: 10.1061/(ASCE)ME.1943-5479.0000279.

RUPARATHNA, R. HEWAGE, K. SADIQ, R. (2017) 'Developing a level of service (LOS) index for operational management of public buildings', Elsevier Ltd, Sustainable Cities and Society, 34 (2017), pp. 159 -173,

RYAN, G. (2018) 'Introduction to positivism, interpretivism and critical theory', *Nurse Researcher*, 25(4), pp. 14–20. doi: 10.7748/nr.2018.e1466.

SAAD, A. AND SHAHARIN, S. (2016) 'The Methodology for Ontology Development in Lesson Plan Domain', *International Journal of Advanced Computer Science and Applications*, 7(4). doi: 10.14569/ijacsa.2016.070472.

SABAEI, D. ERKOYUNCU, J. ROY, R. (2015) 'A review of multi-criteria decision-making methods for enhanced maintenance delivery', CIRPe 2015 - Understanding the life cycle implications of manufacturing, ELSEVIER, Procedia CIRP 37 (2015), pp. 30-35

SABRI, I.A.A. NOOR, N.M.M. ALI, N.H. HITAM, M.S. ISMAIL, F. (2019) ' The SUMI evaluation on island Tourism Advisory System : Itas',

SAGE (2012) 'The SAGE Encyclopedia of Qualitative Research Methods', SAGE Research Methods, SAGE Publications

SANDA, N. Y. DANIEL, M.M. AKANDE, E.M. (2016) 'A Review of Public-Private Partnership for Building and Infrastructure Procurement in Nigeria', 6(2), pp. 5–13. Available at: https://irepos.unijos.edu.ng/jspui/handle/123456789/1663.

SANLI, O. (2019) 'Examining the Effect of Teachers' Perception of Psychological Empowerment on the Stress Level They Perceive', Journal of Education and Training Studies, 7(8), p. 98. doi: 10.11114/jets.v7i8.4283.

SASU, D. D. (2023) 'Human development index of Africa 2021, by country.pdf'.

SAUNDERS, M., LEWIS, P. and THORNHILL, A. (2016) 'Research methods for business students', 7th ed. Pearson

SAUNDERS, M., LEWIS, P. and THORNHILL, A. (2019) 'Research methods. Business Students 4th edition Pearson Education Limited, England.

SCALES, P. (2013) 'An introduction to ontology and epistemology for undergraduate students', *www.Peter-Scales.Org.Uk*, (August), pp. 1–9. Available at: https://www.peter-scales.org.uk/he-and-he-in-fe-resources/.

SCALON, E. SHARPLES, M. FENTON-O'CREEVY, M. FLECK, J. COOBAN, C. FERGUSON, R. CROSS, S. WATERHOUSE, P. (2013) 'BEYOND PROTOTYPES: Enabling innovation in technology-enhanced learning', E.S.R.C. - Economic and Social Research Council, EPSRC - Pioneering research and Skills.

SCARPETTA, S. AND PIERRE, G. (2015) 'Development and Employment: A Mutual Relationship', ScienceDirect, ELSEVIER, pp. 269 -275, DOI: https://doi.org/10.1016/B978-0-08-097086-8.94017-0

SCHARP, K. M. AND SANDERS, M. L. (2019) 'What is a theme? Teaching thematic analysis in qualitative communication research methods', *Communication Teacher*, 33(2), pp. 117–121. doi: 10.1080/17404622.2018.1536794.

SCHMIDT, F. AND HUNTER, J. (2015), Methods of Meta-Analysis: Correcting Error and Bias in Research Findings, Sage Publications, London

SCHOONENBOOM, J. AND JOHNSON, R. B. (2017) 'How to construct a mixed method research design', *Kolner Zeitschrift fur Soziologie und Sozialpsychologie*, 69, pp. 107–131. doi: 10.1007/s11577-017-0454-1.

SCHRAM, A.B. (2014) 'A Mixed Methods Content Analysis of the Research Literature in Science Education', International Journal of Science Education, Routledge, Taylor & Francis, 36 (15), pp. 2619 - 2638, [online] Available from: htttp://dx.doi.org/10.1080/09500693.2014.908328

SCOONES, I. (2016) 'The Politics of Sustainability and Development', *Annual Review of Environment and Resources*, 41, pp. 293–319. doi: 10.1146/annurev-environ-110615-090039.

SHAHEEN, M. (2021) 'The Concept of Originality in Academic Research of Engineering', Hindawi Education Research International, pp. 1 - 14, [online] Available from : https://doi.org/10.1155/2021/9462201

SHANE, J. M. (2012) 'Abandoned Buildings and Lots', Problem-Oriented Guides for Police Problem-Specific Guides Series No. 64, [online], Available, from: https://popcenter.asu.edu/sites/default/files/sites/default/files/problems/pdfs/abandoned_buildings_and_lots.pdf

SHARP, H. PREECE, J. AND ROGERS, Y. (2019) 'Interaction Design: Beyond Human-Computer Interaction' (5th Ed). Wiley.

SHAW, 2010

SHEEBA, S. (2017) 'Postmodern Literature: Practices and Theory', *Excellence International Journal of Education and Research*, 4(3), pp. 181–190.

SHEARD, J. (2018) 'Quantitative data analysis', *Research Methods: Information, Systems, and Contexts: Second Edition*, pp. 429–452. doi: 10.1016/B978-0-08-102220-7.00018-2.

SHEN, H., HU, L. AND LAI, K. K. (2018) 'A Mathematical Programming Model to Determine Objective Weights for the Interval Extension of TOPSIS', *Mathematical Problems in Engineering*, 2018. doi: 10.1155/2018/3783101.

SHETH, A.Z. (2011) 'A refurbishment framework with an emphasis on energy consumption of existing

health care facilities' , A doctoral thesis submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy of Loughborough University.

SIM, J. AND WATERFIELD, J. (2019) 'Focus group methodology: some ethical challenges', *Quality and Quantity*, 53(6), pp. 3003–3022. doi: 10.1007/s11135-019-00914-5.

SIOZINYTE, E. ANTUCHEVICIENE, J. KUTUT, V. (2014) 'Upgrading the old vernacular building to contemporary norms: multiple criteria approach', Journal of Civil Engineering and Management 20(2) 291–298.

SLAPER, T. F. HAL, T.J. (2011) 'The Triple Bottom Line: What Is It and How Does It Work?', *Applied Intelligence*, 10(1), pp. 25–36. doi: 10.1023/A:1008381314159.

SOUTH, L. *ET AL.* (2022) 'Effective Use of Likert Scales in Visualization Evaluations: A Systematic Review', *Computer Graphics Forum*, 41(3), pp. 43–55. doi: 10.1111/cgf.14521.

SPINDOGS (2022) 'Why should you choose cosmetic repair for your next construction project', [online] Available from: https://www.sdsealants.co.uk/news/why-should-you-choose-cosmetic-repair-for-your-next-construction-project/

SREEJESH, S., MOHAPATRA, S. AND ANUSREE, M. R. (2014) *Business research methods: An applied orientation*, *Business Research Methods: An Applied Orientation*. doi: 10.1007/978-3-319-00539-3.

SRIDHAR, K. AND JONES, G. (2013) 'The three fundamental criticisms of the Triple Bottom Line approach: An empirical study to link sustainability reports in companies based in the Asia-Pacific region and TBL shortcomings', *Asian Journal of Business Ethics*, 2(1), pp. 91–111. doi: 10.1007/s13520-012-0019-3.

SRIVASTAVA, A. S. AND NIKHAT PARVEZ, A. (2021) '"GREEN BIM-It's Various Aspects and Future Potential for Construction of Green Building Projects."', *International Journal of Scientific & Engineering Research*, 12(2), pp. 26–39. Available at: http://www.ijser.org.

STAPLES, W. J. AND DALRYMPLE, J. F. (2011) 'Exploring infrastructure procurement by Australian state governments', *International Journal of Managing Projects in Business*, 4(3), pp. 512–523. doi: 10.1108/17538371111144201.

STATISTA (2023) 'African countries with the highest share of global population living below the extreme poverty line in 2022', [online], Available from: Africa: share of global poverty by country 2022 | Statista

STAVOVA, V. UKROP, M. DEDKOVA, L. MATYAS, V. (2018) 'A Large-Scale comparative study of beta testers and regular users', *Communications of the ACM*, 61(2), pp. 64–71. doi: 10.1145/3173570.

STENGEL AND SCHUTT (2016)

STEPHANIE HULL (2021) 'Abandoned Construction Sites in Gauteng – Why ? L2B Blog Subscribe', pp. 1–8.

STURGISS, E.A. CLARK, A.M. (2019) ' Using critical realism in primary care research:
an overview of methods', Oxford University Press, Family Practice, 2020, 143–145, [online] Available from: doi:10.1093/fampra/cmz084.

STUTCHBURY, K. (2022) 'Critical realism: an explanatory framework for small-scale qualitative studies or an "unhelpful edifice"?', *International Journal of Research and Method in Education*, 45(2), pp. 113–128. doi: 10.1080/1743727X.2021.1966623.

STUPAR-RUTENFRANS, S**.** VERDOUW, P.C.D. BOVEN, J.V. RYZHKINA, O.A. BATKHINA, A. AKSOZ-EFE, I. HAMZALLARI, O. PAPAGEORGOPOULOU, P. UKA, F. PETROVIC, N. STATOVCI, A. RUTENFRANS-STUPAR, M. PRANICEVIC, D.G. ZAHAJ, S. MIJTS, E. (2021) 'Ethnic outgroup aggression: A pilot study on

the importance of emotion regulation, nationalism and susceptibility to persuasion', *International Journal of Intercultural Relations*, 84(August 2020), pp. 79–85. doi: 10.1016/j.ijintrel.2021.07.004.

SU, S. LI,S. JU, J. WANG, Q. XU, Z. (2021) **'**A building information modeling-based tool for estimating building demolition waste and evaluating its environmental impacts', *Waste Management*, 134(July), pp. 159–169. doi: 10.1016/j.wasman.2021.07.025.

SUE, V. M. AND RITTER, L. A. (2015) 'Conducting Online Surveys'.

SURUCU, L. MASLAKCI, A. (2020) 'Validity and reliability in quantitative research', Business & management studies: an international journal, BMIJ, 8(3), doi: http://dx.doi.org/10.15295/bmij.v8i3.1540

SUSTAINABILITY, V. I. U., COURSE, S. AND SESSION, F. (no date) *Sustainability in a Time of Crises Sustainability in a Time of Crises*.

SUZUKI, K. PHENG, L.S. (2019) 'Japanese Contractors in Overseas Markets: Bridging Cultural and Communication Gaps', Management in the Built Environment, Springer, Series Editor: Low Sui Pheng, eBook, [online], Available from: https://doi.org/10.1007/978-981-13-7244-5 .

SVENSSON, G. FERRO, C. HØGEVOLD, N. PADIN, C. VARELA, J.C.S. SARSTEDT, M. (2018) 'Framing the triple bottom line approach: Direct and mediation effects between economic, social and environmental elements', *Journal of Cleaner Production*, 197, pp. 972–991. doi: 10.1016/j.jclepro.2018.06.226.

TAHERDOOST, H. AND MADANCHIAN, M. (2023) 'Multi-Criteria Decision Making (MCDM) Methods and Concepts', *Encyclopedia*, 3(1), pp. 77–87. doi: 10.3390/encyclopedia3010006.

TAN, T. MILLS, G. PAPADONIKOLAKI, E. LIU, Z (2021) 'Combining multi-criteria decision making (MCDM) methods with building information modelling (BIM): A review', *Automation in Construction*, 121(September 2020), p. 103451. doi: 10.1016/j.autcon.2020.103451.

TAPPONI, O**.** KASSEM, M. KELLY, G. DAWOOD, N. WHITE, B. (2015) **'**Renovation of Heritage Assets using BIM: a Case Study of the Durham Cathedral', *Proceedings of the 32nd International Conference of CIB W78*, 2010, pp. 706–715.

TAUSCH, A. P. AND MENOLD, N. (2016) 'Methodological Aspects of Focus Groups in Health Research : Results of Qualitative Interviews With Focus Group Moderators'. doi: 10.1177/2333393616630466.

TAVAKOLI, H. AND MARZBALI, M. H. (2021) 'Urban public policy and the formation of dilapidated abandoned buildings in historic cities: Causes, impacts and recommendations', *Sustainability (Switzerland)*, 13(11). doi: 10.3390/su13116178.

TENNENT, K.D. GILLETT, A.G. FOSTER, W.M.(2020) ' Developing historical consciousness in management learners', Management Learning, 51 (1), pp. 73-88, [online] Available from: https://doi.org/10.1177/1350507619869669

THACKER, S. ADSHEAD, D. FAY, M. HALLEGATTE, S. HARVEY, M. MELLER, H. O'REGAN, N. ROZENBERG, J. WATKINS, G. HALL, J.W. (2019) 'Infrastructure for sustainable development', *Nature Sustainability*, 2(4), pp. 324–331. doi: 10.1038/s41893-019-0256-8.

THATCHER, A. (2013) 'Defining Human Factors for Sustainable Development', [online] Available from: HFSDdefinitionworkingpaper19_08_2013 (1).pdf

THE ECONOMIST (2019) 'The critical role of infrastructure for the Sustainable Development Goals', Intelligence Unit, UNOPS, [online] Available from: https://content.unops.org/publications/The-critical-role-of-infrastructure-for-the-SDGs_EN.pdf

TIE, Y. C., BIRKS, M. AND FRANCIS, K. (2019) 'Grounded theory research : A design framework for

novice researchers'. doi: 10.1177/2050312118822927.

TIJAN, M. AND AJAGBE, W. (2016) 'Professional view on the causes and effects of construction projects abandonment in Ibadan metropolis, Nigeria', *Ethiopian Journal of Environmental Studies and Management*, 9(5), p. 593. doi: 10.4314/ejesm.v9i5.6.

TIKLY, L. (2015) 'What works, for whom, and in what circumstances? Towards a critical realist understanding of learning in international and comparative education', *International Journal of Educational Development*, 40, pp. 237–249. doi: 10.1016/j.ijedudev.2014.11.008.

TOMIC, L.. MARIČIĆV.K. DANILOVIĆ, D. LEKOVIĆ, B. CRNOGORAC, M. (2019) ' Application of the promethee and vikor methods for selecting the most suitable carbon dioxide geological storage option', Underground mining engineering, University of Belgrade - faculty of mining and geology 34 (2019), pp. 43-57

TOPPR (2022) ' What are the two main types of infrastructure?', [online], Available from: https://www.toppr.com/ask/question/what-are-the-two-main-types-of-infrastructure/

TORCHIANO, M. ET AL. (2017) 'Lessons Learnt in Conducting Survey Research', *Proceedings - 2017 IEEE/ACM 5th International Workshop on Conducting Empirical Studies in Industry, CESI 2017*, (February), pp. 33–39. doi: 10.1109/CESI.2017.5.

TORIOLA-COKER, L. O. ALAKA, H. BELLO, W.A. AJAYI, S. ADENIYI, A. OLOPADE, S.O. (2021) 'Sustainability Barriers in Nigeria Construction Practice', *IOP Conference Series: Materials Science and Engineering*, 1036(1), p. 012023. doi: 10.1088/1757-899x/1036/1/012023.

TODOROV, V.I MARINOVA,D (2009) 'Models of Sustainability', 18th World IMACS / MODSIM Congress, Cairns, Australia 13-17 July 2009, [online] Available from: https://core.ac.uk/download/pdf/195654977.pdf

TOYNBEE, P. (2023) 'Here's what we know about Sunak now: where the anti-green extremists lead, he will follow', The Guardian, [online] Available from: Here's what we know about Sunak now: where the anti-green extremists lead, he will follow | Polly Toynbee | The Guardian

TRAMPUS, P. (2014) 'Ensuring Safety of Structures and Components at Nuclear Power Plants', Procedia Engineering 86 (2014), ScienceDirect, ELSEVEIR, 1st International Conference on Structural Integrity, ICONS-2014, pp: 486 – 495, DOI: doi: 10.1016/j.proeng.2014.11.062

TRAUBE, D. E. BEGUN, S. PETERING, R. FLYNN, M.L. (2017) 'Beta Testing in Social Work', *Research on Social Work Practice*, 27(2), pp. 163–168. doi: 10.1177/1049731516659142.

TRINH, H. T. M. K. CHOWDHURY, S. DOH, J. LIU, T. (2021) 'Environmental considerations for structural design of flat plate buildings – Significance of and interrelation between different design variables', Journal of Cleaner Production, 315(May), p. 128123. doi: 10.1016/j.jclepro.2021.128123.

TSANGAS, M. JEGUIRIM, M. LIMOUSY, L. ZORPAS, A. (2019) 'The application of analytical hierarchy process in combination with PESTEL-SWOT analysis to assess the hydrocarbons sector in Cyprus' Energies, 12(5), p.791.

TURNER, C. (2020), 'Soft Infrastructure', Social and Political Science, Monograph Chapter, pp. 130-151, DOI: https://doi.org/10.4337/9781788970310.00013

TUTZ, G. (2021) 'Hierarchical Models for the Analysis of Likert Scales in Regression and Item Response Analysis', *International Statistical Review*, 89(1), pp. 18–35. doi: 10.1111/insr.12396.

UBANI, E. AND ONONUJU, C. (2013) 'A study of failure and abandonment of public sector-driven civil engineering projects in Nigeria: An empirical review', *American Journal of Scientific and Industrial Research*, 4(1), pp. 75–82. doi: 10.5251/ajsir.2013.4.1.75.82.

UDDIN, W. HUDSON, W.R. HAAS, R. (2013) 'Public InfrastructureAsset Management', *McGraw Hill Education*, Second Edition, United State of America.

UK GOVERNMENT (2015) 'Public procurement policy. [online] United Kingdom: Government Digital Service', [online] Available from: https://www.gov.uk/guidance/public-sector-procurement-policy [Accessed 18th January 2020]

UK GOVERNMENT (2023) 'Thousands of new homes to be built on regenerated brownfield land', [online], Available from: https://www.gov.uk/government/news/thousands-of-new-homes-to-be-built-on-regenerated-brownfield-land

UMAR, S.B. SAID, I. (2019) 'Conservation Challenges of Heritage Building Reuse in Nigeria: A review of decision-making models', Asian Journal of Environment-Behaviour Studies, 4(12) pp. 16-36.

UNCTAD (2022) 'Now 8 billion and counting: Where the world's population has grown most and why that matters', *United Nations Conference on Trade and Development*. Available at: https://unctad.org/data-visualization/now-8-billion-and-counting-where-worlds-population-has-grown-most-and-why.

UNSDG REPORT (2022) 'Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation', [online] Available from: https://www.un.org/sustainabledevelopment/infrastructure-industrialization/

UNUTMAZ DURMUŞOĞLU, Z. D. AND DURMUŞOĞLU, A. (2021) 'A TOPSIS model for understanding the authors choice of journal selection', *Scientometrics*, 126(1), pp. 521–543. doi: 10.1007/s11192-020-03770-5.

USADOLO, Q. (2017) 'The impact of social exchange on volunteer ' s workplace outcomes in non-profit organisations', (April).

VACCHI, M. SILIGARDI, C. DEMARIA, F. CEDILLO-GONZÁLEZ, E.I. GONZÁLEZ-SÁNCHEZ, R. SETTEMBRE-BLUNDO, D. (2021) 'Technological sustainability or sustainable technology? A multidimensional vision of sustainability in manufacturing', *Sustainability (Switzerland)*, 13(17), pp. 1–18. doi: 10.3390/su13179942.

VAFAEI, N. RIBEIRO, R. A. AND CAMARINHA-MATOS, L. M. (2018) 'Data normalisation techniques in decision making: Case study with TOPSIS method', *International Journal of Information and Decision Sciences*, 10(1), pp. 19–38. doi: 10.1504/IJIDS.2018.090667.

VAISMORADI, M., TURUNEN, H. and BONDAS, T., 2013. Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. Nursing & health sciences, 15(3), pp. 398-405.

VASSONEY, E**.** MOCHET, A. M. DESIDERIO, E. NEGRO, G. PILLONI, M.G. COMOGLIO, C. (2021) 'Comparing Multi-Criteria Decision-Making Methods for the Assessment of Flow Release Scenarios From Small Hydropower Plants in the Alpine Area', *Frontiers in Environmental Science*, 9(April). doi: 10.3389/fenvs.2021.635100.

VIETKAP TEAM (2021) ' Primary data survey: a step-by-step procedure for researchers in social sciences and humanities', https://doi.org/10.31219/osf.io/qpa9t

VILLORIA SÁEZ, P., DEL RÍO MERINO, M. AND PORRAS-AMORES, C. (2012) 'Estimation of construction and demolition waste volume generation in new residential buildings in Spain', *Waste Management and Research*, 30(2), pp. 137–146. doi: 10.1177/0734242X11423955.

VIVEKH, P. SUDHAKAR, P. SRINIVAS, M. VISHWANTHKUMAR, V. (2016) 'Desalination technology selection using multi-criteria evaluation: TOPSIS and PROMETHEE-2', *International Journal of Low-Carbon Technologies*, 12(1), pp. 24–35. doi: 10.1093/ijlct/ctw001.

VIZZARRI, C. (2020) 'The refurbishment of abandoned industrial areas with adaptive re-use strategies: analysis of decision making models and design criteria', *Journal of Urban Environment*, (April), pp. 15–

28. doi: 10.34154/2020-jue-0101-15-28/euraass.

VASSONEY, E. MOCHET, A.M. DESIDERIO, E. NEGRO, G. PILLONI, M.G. COMOGLIO, C. (2020) ' Comparing Multi Criteria Decision Making Methods for the Assessment of flow release scenarios from small hydropower plant in the alpine area', Frontiers in Environmental Science, [online] Available from: https://doi.org/10.3389/fenvs.2021.635100

VOLK, R., STENGEL, J. AND SCHULTMANN, F. (2014) 'Building Information Modeling (BIM) for existing buildings - Literature review and future needs', *Automation in Construction*, 38, pp. 109–127. doi: 10.1016/j.autcon.2013.10.023.

VOMMI, V. B. (2017) 'TOPSIS with statistical distances : A new approach to MADM TOPSIS with statistical distances : A new approach to MADM', (June). doi: 10.5267/j.dsl.2016.8.001.

WAHAB, B. (2020) 'Abandoned Federal Govt buildings in Lagos are now homes to miscreants and robbers', *Pulse, Nigeria*. Available at: https://www.pulse.ng/news/local/abandoned-federal-govt-buildings-in-lagos-are-now-homes-to-miscreants-and-robbers/33e14hx.

WAHEED UDDIN, RONALD HUDSON, R. H. (2013) *Public Infrastructure Asset Management*.

WALKER, C. BAXTER, J. (2019) ' Method Sequence and Dominance in Mixed Methods Research: A Case Study of the Social Acceptance of Wind Energy Literature', International Journal of Qualitative Methods, SAGE, 18, pp. 1-14, DOI: 10.1177/1609406919834379,

WALKER, H. BRAMMER, S. (2009) 'Sustainable procurement in the United Kingdom public sector', 2, pp. 128–137. doi: 10.1108/13598540910941993.

WALKER, H. BRAMMER, S.(2012) ' The relationship between sustainable procurement and e-procurement in the public sector', International Journal of Production Economics 140 (1), pp. 256-268

WALLACE, D. AND SCHALLIOL, D. (2015) 'Testing the temporal nature of social disorder through abandoned buildings and interstitial spaces', *Social Science Research*, 54, pp. 177–194. doi: 10.1016/j.ssresearch.2015.06.013.

WANG, Y., YE, G., ZHENG, C., & ZHANG, S. (2021) 'Total factor productivity growth and its decomposition in the Chinese construction industry since China's accession to the World Trade Organization', *Engineering, Construction and Architectural Management*.

WANG, C. TSAI, H. HO, T. NGUYEN, V. HUANG, Y. (2020) 'Multi-Criteria Decision Making (MCDM) Model for Supplier Evaluation and Selection for Oil Production Projects in Vietnam', MDPI, Processes, 2020 (8), doi:10.3390/pr8020134. pp 1-13

WANG, C. N. HUANG, Y. CHAI, Y. NGUYEN, V. (2018) *A Multi-Criteria Decision Making (MCDM) for renewable energy plants location selection in Vietnam under a fuzzy environment*, *Applied Sciences (Switzerland)*. doi: 10.3390/app8112069.

WĄTRÓBSKI, J. BĄCZKIEWICZ, A. ZIEMBA, E. SAŁABUN, W (2022) 'Sustainable cities and communities assessment using the DARIA-TOPSIS method', *Sustainable Cities and Society*, 83(April), p. 103926. doi: 10.1016/j.scs.2022.103926.

WEIJNEN, M. P. C., LUKSZO, Z. AND FARAHANI, S. (2021) *Shaping an Inclusive Energy Transition*, *Shaping an Inclusive Energy Transition*. doi: 10.1007/978-3-030-74586-8.

WEINBERGER, K. RANKINE, H. AMANUMA, N. SURENDRA, L. HULL, H.V.V. (2015) 'Integrating the three dimensions of sustainable development: A framework and tools', *United Nations publication*, p. 33. Available at: www.unescap.org.

WELLCOMETRUST (2014) 'Ensuring your research is ethical : A guide for Extended Project Qualification students'.

WICKRAMAARACHCHI, N. C., SEWWANDI, S. AND THILINI, K. A. M. (2021) 'Landowners' perceptions towards the success of land title registration in Sri Lanka', *Bhumi, The Planning Research Journal*, 8(1), p. 3. doi: 10.4038/bhumi.v8i1.74.

WIDYANINGRUM, H. K. HASANUDIN, C. FITRIANINGSIH, A. NOVIANTI, D.E. SADDHONO, K. SUPRATMI, N. (2020) 'The use of Edmodo apps in flipped classroom learning. How is the students' creative thinking ability?', *Ingenierie des Systemes d'Information*, 25(1), pp. 69–74. doi: 10.18280/isi.250109.

WIECEK - JANKA, E. (2015) 'The essential of marketing research', Poznan University of Technology Publishing House, Poznan.

WILLIAMS, B. HALLOIN, C. LÖBEL, W. FINKLEA, F. LIPKE, E. ZWEIGERDT, R. CREMASCHI, S. (2020) *Data-Driven Model Development for Cardiomyocyte Production Experimental Failure Prediction*, *30th European Symposium on Computer Aided Chemical Engineering*. Elsevier Masson SAS. doi: 10.1016/B978-0-12-823377-1.50274-3.

WILLIAMS, T. A. AND SHEPHERD, D. A. (2017) 'Mixed Method Social Network Analysis: Combining Inductive Concept Development, Content Analysis, and Secondary Data for Quantitative Analysis', *Organizational Research Methods*, 20(2), pp. 268–298. doi: 10.1177/1094428115610807.

WILSON, G. (2013) 'an Integrated Decision Support Model for the Sustainable Refurbsihment of Hospitals and Healthcare Facilities: Developing a Prototype', A thesis submitted in partial fulfillment of the Requirements of the Robert Gordon UniversityFor the degree of Doctor of Philosophy (1). Available at: http://eprints.qut.edu.au/29653/.

WOKA, P. AND MIEBAKA, A. (2014) 'an Assessment of the Causes and Effects of Abandonment of Development Projects on Real Property Values in Nigeria', *International Journal of Research in Applied, Natural and Social Sciences*, 2(2), pp. 25–36. Available at: http://dictionary.reference.com/browse/abandonment;akogun

WOOD, B. Y. G. (2021) 'Jozi ' s abandoned Carlton Hotel was once super luxe . Now it looks like this'.

WORLDATLAS (2017) 'How Many Countries In Africa?', *Science Trends*, pp. 1–5. doi: 10.31988/scitrends.4713.

WORLDDATA (2023) 'Developing Countries', [online] Available from: https://www.worlddata.info/developing-countries.php

WORLD TRADE ORGANISATION (WTO) (2023) 'Who are the developing countries in the WTO?', [online], Available from: https://www.wto.org/english/tratop_e/devel_e/d1who_e.htm

WREN, Y., TITTERINGTON, J. AND WHITE, P. (2020) 'How many words make a sample? Determining the minimum number of word tokens needed in connected speech samples for child speech assessment', *Clinical Linguistics and Phonetics*, 35(8), pp. 761–778. doi: 10.1080/02699206.2020.1827458.

YANAMANDRA, S. (2020) ' Sustainable Infrastructure: An Overview Placing infrastructure in the context of sustainable development', University of Cambridge Institute for Sustainability Leaderships' 1-57

YANG, Z**.** QIU, Z. ZHOU, Y. HUANG, Z. BODEVEIX, J. FILALI, M. (2021) **'C**2AADL_Reverse: A model-driven reverse engineering approach for development and verification of safety-critical software', *Journal of Systems Architecture*, 118. doi: 10.1016/j.sysarc.2021.102202.

YIN, R.K (2018) 'Case Study Research and Applications : Design and Methods (6th ed.) Thousands Oaks, CA: Sage

YOUNG, M. E., BELL, Z. E. AND FRISTAD, M. A. (2016) 'Validation of a Brief Structured Interview : The Children ' s Interview for Psychiatric Syndromes (ChIPS)', *Journal of Clinical Psychology in Medical*

Settings, 23(4), pp. 327–340. doi: 10.1007/s10880-016-9474-7.

YUNG, E. H. K. AND CHAN, E. H. W. (2012) 'Implementation challenges to the adaptive reuse of heritage buildings: Towards the goals of sustainable, low carbon cities', *Habitat International*, 36(3), pp. 352–361. doi: 10.1016/j.habitatint.2011.11.001.

ZAVADSKAS, E.K ANTUCHEVICIENE, J. (2008) 'Modelling multidimensional redevelopment of derelict buildings', International Journal of Environment and Pollution 35(2/3/4), pp: 331–344.

ZHANG, C., DAI, S. AND XIA, H. (2020) 'Reuse of Abandoned Railways Leads to Urban Regeneration: A Tale from a Rust Track to a Green Corridor in Zhangjiakou', *Urban Rail Transit*, 6(2), pp. 104–115. doi: 10.1007/s40864-020-00127-2.

ZHANG, Y. GUANGMIN, Z. GUO, P. (2021) 'Regeration path of abandoned industrial buildings: The moderating role of the goodness of regeration mode', *Journal of Cleaner Production*, *ELSEVIER*, (297), pp 1-11, http://www.elsevier.com/locate/jclepro.

ZHAO, D. Y., MA, Y. Y. AND LIN, H. L. (2022) 'Using the Entropy and TOPSIS Models to Evaluate Sustainable Development of Islands: A Case in China', *Sustainability (Switzerland)*, 14(6), pp. 1–25. doi: 10.3390/su14063707.

ZHENG, L. AN, H. YUE, J. LIU, P. LI, P. (2021) 'A New Method for Determining Abandonment Formation Pressure in Sulige Gas Field,' *Springer Series in Geomechanics and Geoengineering*. Springer Singapore. doi: 10.1007/978-981-16-0761-5_49.

ZHOU, Y. BAI, L. GUO, H. GUO, S. HAN, X. YUE, N.J. LI, Q**.** (2021) 'SWOT Analysis and Preliminary Study on Prevention and Control Management of Temporary Integrated Isolation Ward During COVID-19 Outbreak', *Frontiers in Public Health*, 9(March), pp. 1–7. doi: 10.3389/fpubh.2021.558565.

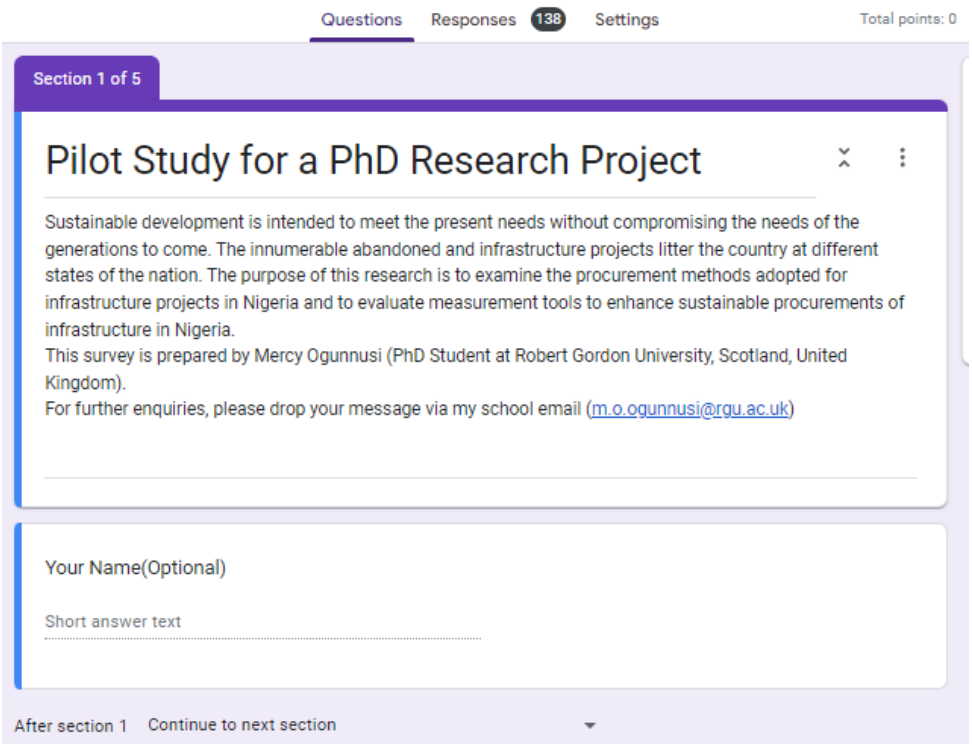
ZHOU, Z. DOU, Y. ZHANG, X. ZHAO, D. TAN, Y. (2018) 'A group decision-making model for wastewater treatment plans selection based on intuitionistic fuzzy sets', *Journal of Environmental Engineering and Landscape Management*, 26(4), pp. 251–260. doi: 10.3846/jeelm.2018.6122.

ZOHRABI, M. (2013) 'Mixed method research: Instruments, validity, reliability and reporting findings', *Theory and Practice in Language Studies*, 3(2), pp. 254–262. doi: 10.4304/tpls.3.2.254-262.

Zavadskas, E. K., Antucheviciene, J. and Chatterjee, P. (2018) *Multiple-criteria decision-making (MCDM) techniques for business processes information management*, *Information (Switzerland)*. doi: 10.3390/info10010004.

ZUKAUSKAS, P. VVEINHARDT, J. ANDRIUKAITIENĖ, R. (2018) 'Philosophy and Paradigm of Scientific Research', IntechOpen, WEB OF SCIENCE, Chapter 6, [online], Available from : http://dx.doi.org/10.5772/intechopen.70628

APPENDIX 1: STUDY ONE QUESTIONNAIRE.



Section 2 of 5

General Information

Description (optional)

Profession *

1. Architect
2. Engineer
3. Builder
4. Surveyor
5. Developer
6. Construction Procurement Personnel
7. Project Manager
8. Others

3- Years of Experience in the industry: *

- ○ not experienced (>1)
- ○ somewhat experienced (1-5 years of experience)
- ○ experienced (5-10 years of experience)
- ○ very experienced (more than 15 years of experience)
- ○ Other...

4- Category of Industry? *

- Public Sector
- Private Sector
- Both
- Other...

5- Which form of contract do you use mostly in your organisation? *

- FIDIC (International Federation of Consulting Engineers)
- JCT (Joint Contracts Tribunal)
- NEC (New Engineering Contract)
- All of the above
- Other...

6- Which part of Nigeria are you located (Sub geographical zone)? *

- North West
- North East
- North Central
- South West
- South East
- South South
- Other...

After section 2 Continue to next section

Section 3 of 5

Abandoned Projects

Abandoned or Incomplete infrastructure projects are those that are not occupied or not in use.

7- Have you been involved in construction projects that failed and were subsequently abandoned?

- Yes
- No
- Maybe

8- What do you think of abandoned and incomplete infrastructure projects/ buildings in Nigeria? *

Long answer text

9- If you have been involved in abandoned projects, could you please state the cause(s) for such projects failure?

Long answer text

10- In your opinion, what do you think is the impact of abandoned Infrastructure in Nigeria?

- Non eco-friendly
- Uneconomical
- Constitute social menace
- Waste of useful resources
- All of the above
- Other...

11- As a professional, what do you think is the remedy for abandoned projects in Nigeria (tick as many):

- [ ] designing with deconstructability in mind
- [ ] using an innovative managemenet tool
- [ ] refurbishment of abandoned projects
- [ ] changing procurement methods
- [ ] Other...

After section 3 Go to section 4 (Procurement Methods)

Section 4 of 5

Procurement Methods

Procurement is "the process by which organisation acquire the products and services necessary for the achievement of their objectives at the best possible cost, quality and timing in a way which does not damage the environment or society"

12- What are the main procurement methods adopted in Nigeria that you may have used in the past?

Long answer text

13- What are the main procurement methods adopted in abandoned infrastructure that you may have worked with in the past?

Long answer text

14- Any idea of technological tools that we can use to drive sustainable procurement of infrastructure in Nigeria?

Long answer text

15- Have you had to considered/utilised the tool mentioned above during any stage of your projects?

- ○ Yes
- ○ No
- ○ Maybe

16- The Procurement Act of 2007 in Nigeria does not address sustainable development. What are some of the changes that you would like to propose to bring into current realities of global sustainability?

Long answer text

After section 4 Go to section 5 (Green BIM)

Section 5 of 5

Green BIM

"BIM(Building Information Modelling) is an intelligent 3D model-based process that gives architecture, engineering and construction(AEC) professionals the insight and tools to more efficiently plan, design, construct and manage building and infrastructure."

Green BIM is the application of "BIM along with sustainable design and construction techniques."

17- Are you aware of the application of BIM and Green BIM?

- ☐ BIM
- ☐ Green BIM
- ☐ Both
- ☐ Not at all.
- ☐ Other...

18- If you are aware of BIM or Green BIM, have you used either or both of them in any of the projects that you are involved with?

- ○ Yes
- ○ No
- ○ Maybe

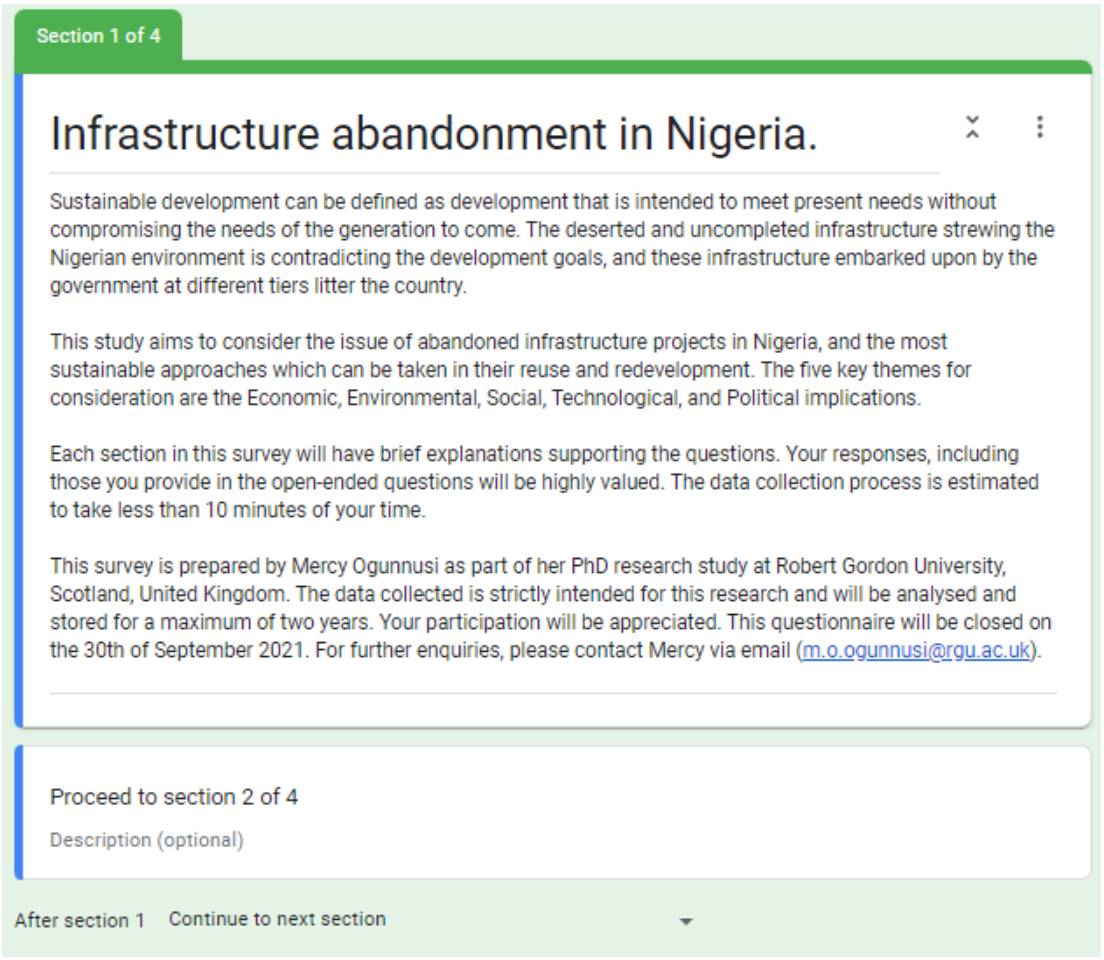
19- This research recommends the application of Green Building Information Modeling(Green BIM) and Management in procurement of Infrastructure projects in Nigeria as a sustainable tool to enhance the successful completion of construction projects from design to construction, operation, demolition and deconstruction (instead of abandonment). To what extent do you agree with this recommendation

- [ ] Strongly disagree
- [ ] Disagree
- [ ] Neutral
- [ ] Agree
- [ ] Strongly agree

20- If you are interested in this study and its results, please provide a valid email address:

Short answer text

APPENDIX 2: STUDY TWO QUESTIONNAIRE



Section 1 of 4

Infrastructure abandonment in Nigeria.

Sustainable development can be defined as development that is intended to meet present needs without compromising the needs of the generation to come. The deserted and uncompleted infrastructure strewing the Nigerian environment is contradicting the development goals, and these infrastructure embarked upon by the government at different tiers litter the country.

This study aims to consider the issue of abandoned infrastructure projects in Nigeria, and the most sustainable approaches which can be taken in their reuse and redevelopment. The five key themes for consideration are the Economic, Environmental, Social, Technological, and Political implications.

Each section in this survey will have brief explanations supporting the questions. Your responses, including those you provide in the open-ended questions will be highly valued. The data collection process is estimated to take less than 10 minutes of your time.

This survey is prepared by Mercy Ogunnusi as part of her PhD research study at Robert Gordon University, Scotland, United Kingdom. The data collected is strictly intended for this research and will be analysed and stored for a maximum of two years. Your participation will be appreciated. This questionnaire will be closed on the 30th of September 2021. For further enquiries, please contact Mercy via email (m.o.ogunnusi@rgu.ac.uk).

Proceed to section 2 of 4

Description (optional)

After section 1 Continue to next section

Section 2 of 4

Demography

Description (optional)

1) Profession

- 1- Architect
- 2- Building Engineer
- 3- Civil/Structuctural Engineer
- 4- Electrical Engineer
- 5- Mechanical Engineer
- 6- Construction / Project Manager
- 7- Quantity Surveyor
- 8- Property Developer
- 9- Contractor
- Other...

2) Years of Experience

- 1- Somewhat experienced (<5 years of experience)
- 2- Experienced (5-10years of experience)
- 3- Very experienced (11-15years of experience)
- 4- Highly experienced (more than 15years of experience)

3) Academic qualification (tick the highest that applies)

- 1- College / Ordinary National Diploma (OND)
- 2- Higher National Diploma (HND)
- 3- First Degree
- 4- MSc
- 5- PhD

4) In which part of Nigeria are you located?

- 1- South - West
- 2- South - East
- 3- South - South
- 4- North - Central
- 5- North - East
- 6- North - West

5) Which sector do you operate in?

- 1- Public Sector
- 2- Private Sector
- 3- Both (Public and Private)

Proceed to Section 3 of 4

Description (optional)

After section 2 Continue to next section

Section 3 of 4

Background - Abandoned Projects

Abandoned buildings can be described as projects that have started at an earlier date, but which the construction for one reason or the other has stopped, or existing structures that were initially occupied and subsequently vacated with no intention of when to resume utilisation.

6) What is the level of your awareness of abandoned projects in Nigeria?

- 1- Not aware
- 2- Aware
- 3- Well informed
- 4- Witnessed
- 5- Participated

7) Please list the abandoned infrastructure (government or private projects) which you are personally familiar with in Nigeria (e.g., Federal Secretariat - Government projects)

Long answer text

Proceed to section 4 of 4

Description (optional)

After section 3 Continue to next section

Section 4 of 4

Sustainability Consideration

The aspiration of sustainable development is not only to build new urban areas, but to develop abandoned territories. The five key attributes for consideration in this section are Economic, Environmental and Social, Technological and Political considerations of addressing abandoned infrastructure in Nigeria.

(8) Please indicate your own level of awareness of sustainability issues in the context of environmental, economic, technological, social, and political dimensions.

	1- No or low a...	2- Basic aware...	3- Average awa...	4- Good aware...	5- High awaren...
Environmental	○	○	○	○	○
Economic	○	○	○	○	○
Social	○	○	○	○	○
Technological	○	○	○	○	○
Political	○	○	○	○	○

9) How can the abandoned National Provident Fund Building, Badagry Way- Lagos/Nigeria, be redeveloped in the most sustainable way? https://www.pulse.ng/news/local/abandoned-federal-govt-buildings-in-lagos-are-now-homes-to-miscreants-and-robbers/33e14hx

	1- Strongly dis...	2- Disagree	3- Unsure	4- Agree	5- Strongly agr...
1- Refurbishme...	○	○	○	○	○
2- Conversion ...	○	○	○	○	○
3- Demolition o...	○	○	○	○	○
4- Procurement...	○	○	○	○	○

10) How can the abandoned Federal Secretariat, Lagos State, Nigeria be redeveloped in the most sustainable way? https://tribuneonlineng.com/fresh-concerns-over-abandoned-fgs-properties-in-lagos/

	1- Strongly dis...	2- Disagree	3- Unsure	4- Agree	5- Strongly agr...
1- Refurbishme...	○	○	○	○	○
2- Conversion ...	○	○	○	○	○
3- Demolition o...	○	○	○	○	○
4- Procurement...	○	○	○	○	○

11) How relevant would you consider the following factors while refurbishing or maintaining the original buildings (Refer to Q9 & Q10) for their historical purposes? *

	1 - Least releva...	2 - Low relevan...	3 - Moderate re...	4 - High releva...	5 - Highest rele...
Project prepara...	○	○	○	○	○
Creation of em...	○	○	○	○	○
Energy efficiency	○	○	○	○	○
Waste generati...	○	○	○	○	○
Preservation of...	○	○	○	○	○
Investments	○	○	○	○	○
Profitability	○	○	○	○	○
Structural integ...	○	○	○	○	○
Government re...	○	○	○	○	○
CO2 emissions	○	○	○	○	○

12) How relevant would you consider the following factors, while converting the buildings (Refer to Q9 & Q10) into apartment housing and preserving their architectural-urban expression? *

	1 – Least relev...	2 – Low releva...	3 - Moderate re...	4 – High releva...	5 – Highest rel...
Project prepara...	○	○	○	○	○
Creation of em...	○	○	○	○	○
Energy efficiency	○	○	○	○	○
Waste generati...	○	○	○	○	○
Preservation of...	○	○	○	○	○
Investments	○	○	○	○	○
Profitability	○	○	○	○	○
Structural integ...	○	○	○	○	○
Government re...	○	○	○	○	○
CO2 emissions	○	○	○	○	○

13) How relevant would you consider the following factors, for the demolition of any of the buildings (Refer to Q9 & Q10) and the implementation of a new design? *

	1 – Least relev...	2 – Low releva...	3 - Moderate re...	4 – High releva...	5 – Highest rel...
Project prepara...	○	○	○	○	○
Creation of em...	○	○	○	○	○
Energy efficiency	○	○	○	○	○
Waste generati...	○	○	○	○	○
Preservation of...	○	○	○	○	○
Investments	○	○	○	○	○
Profitability	○	○	○	○	○
Structural integ...	○	○	○	○	○
Government re...	○	○	○	○	○
CO2 emissions	○	○	○	○	○

14) How relevant would you consider the following factors, with procurement or selling of these buildings (Refer to Q9 & Q10) to private sector / entities or investors? *

	1 – Least relev...	2 – Low releva...	3 - Moderate re...	4 – High releva...	5 – Highest rel...
Project prepara...	○	○	○	○	○
Creation of em...	○	○	○	○	○
Energy efficiency	○	○	○	○	○
Waste generati...	○	○	○	○	○
Preservation of...	○	○	○	○	○
Investments	○	○	○	○	○
Profitability	○	○	○	○	○
Structural integ...	○	○	○	○	○
Government re...	○	○	○	○	○
CO2 emissions	○	○	○	○	○

15) What do you feel would be the best way (with sustainability in mind) to address the abandonment of infrastructure in Nigeria?

Long answer text

16) As this is an ongoing research study, please provide your name and/or a valid email address if you might be interested in participating in later stages.

Short answer text

APPENDIX 3: CORRESPONDENCE WITH A PARTICIPANT FOR THE SEMI-STRUCTURED INTERVIEW

Data Collection for a PhD Research Project.

MERCY OGUNNUSI (1406849)
To: baseconsultants@yahoo.com
Thu 23/12/2021 2:36 PM

Hello Architect (Baseconsultants),

I trust that you are doing great and compliments of the season.

Thank you for your interest in participating in this ongoing research.

Having analyzed all the last data collected on the topic - **Infrastructure Abandonment in Nigeria**, I discovered that there are some grey areas from some of the responses that need further clarification. In view of this, there will be a **semi-structured interview** with you via **zoom**. This will be within the first quarter of next year 2022. I have identified you as one of the participants for this next stage based on your wealth of experience as indicated in the survey.

Kindly oblige my request in preparation for this next phase. **On your acceptance,** I will revert to you with a consent form in January 2022 to also obtain the most convenient day for you.

Looking forward to your response soon.

Best regards.

Mercy.

Mercy Ogunnusi (Mrs)
HND, PGD, Msc, PgCert, **AFHEA**, **MCIOB.**

PhD Candidate
Scott Sutherland School of Architecture and Built Environment
The Sir Ian Wood Building
Robert Gordon University
Riverside East, Garthdee Road
Aberdeen, AB10 7GJ
Scotland, United Kingdom

Fulfilling my passion without sense of guilt - .Myles Munroe

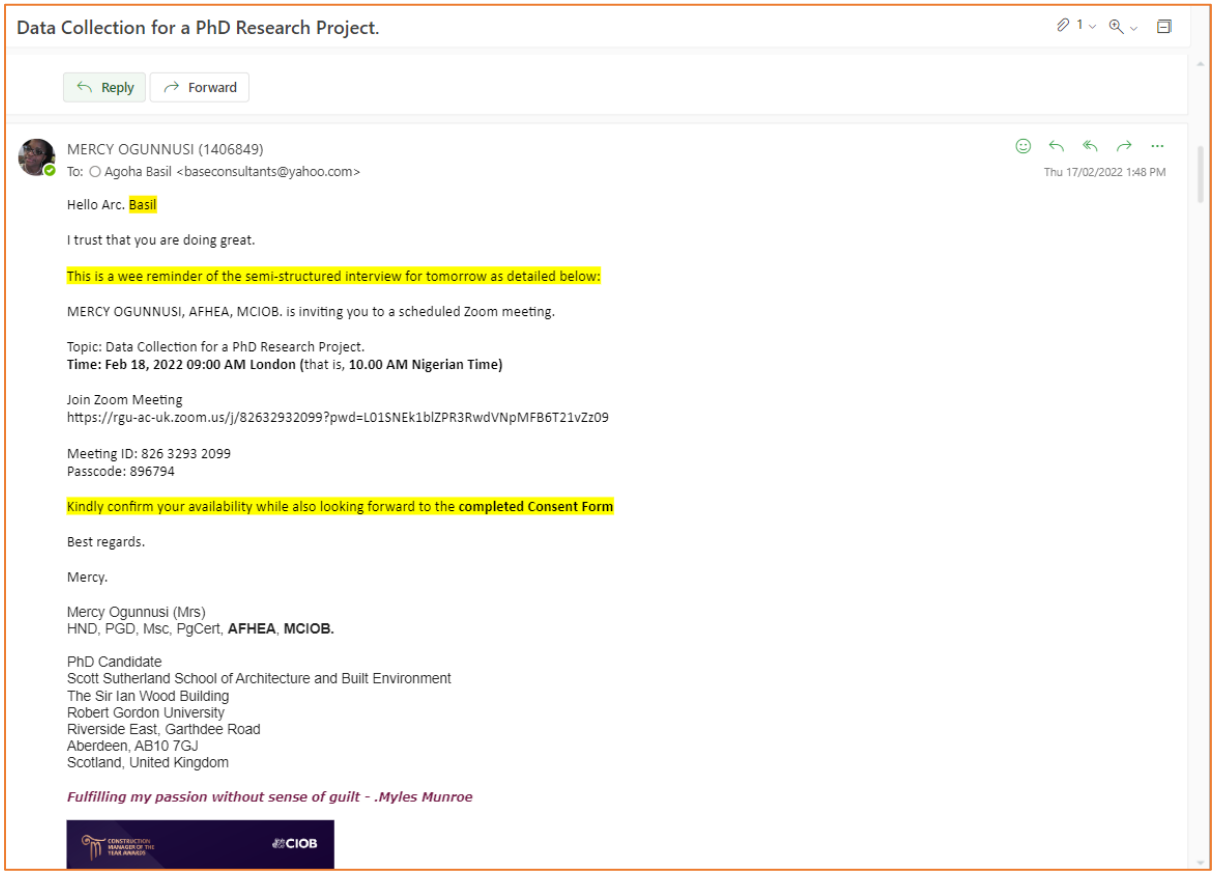
APPENDIX 4: CONFIRMATION OF ACCEPTANCE

AB
Agoha Basil <baseconsultants@yahoo.com>
To: MERCY OGUNNUSI (1406849)
Thu 27/01/2022 6:36 PM

Noted. Please send a reminder on February 10. Thanks. Basil Agoha

Sent from Yahoo Mail on Android

APPENDIX 5: ZOOM LINK VIA EMAIL FOR THE ONLINE INTERVIEW



Data Collection for a PhD Research Project.

Reply Forward

MERCY OGUNNUSI (1406849)
To: Agoha Basil <baseconsultants@yahoo.com>
Thu 17/02/2022 1:48 PM

Hello Arc. Basil

I trust that you are doing great.

This is a wee reminder of the semi-structured interview for tomorrow as detailed below:

MERCY OGUNNUSI, AFHEA, MCIOB. is inviting you to a scheduled Zoom meeting.

Topic: Data Collection for a PhD Research Project.
Time: Feb 18, 2022 09:00 AM London (that is, 10.00 AM Nigerian Time)

Join Zoom Meeting
https://rgu-ac-uk.zoom.us/j/82632932099?pwd=L01SNEk1blZPR3RwdVNpMFB6T21vZz09

Meeting ID: 826 3293 2099
Passcode: 896794

Kindly confirm your availability while also looking forward to the **completed Consent Form**

Best regards.

Mercy.

Mercy Ogunnusi (Mrs)
HND, PGD, Msc, PgCert, **AFHEA**, **MCIOB.**

PhD Candidate
Scott Sutherland School of Architecture and Built Environment
The Sir Ian Wood Building
Robert Gordon University
Riverside East, Garthdee Road
Aberdeen, AB10 7GJ
Scotland, United Kingdom

Fulfilling my passion without sense of guilt - .Myles Munroe

APPENDIX 6: QUESTIONS FOR THE SEMI-STRUCTURED INTERVIEW

Introductory Statement…….

- Appreciation
- Aim of the interview
- Timing confirmation
- Validation of the acceptance for the participation
- Ethical consideration / Confidentiality
- Demographic information – Profession, Years of experience, Sector….

1) From your response to (Q6) within the online survey, you are “well- informed” about abandoned projects in Nigeria. Can you share your experience about these abandonments?

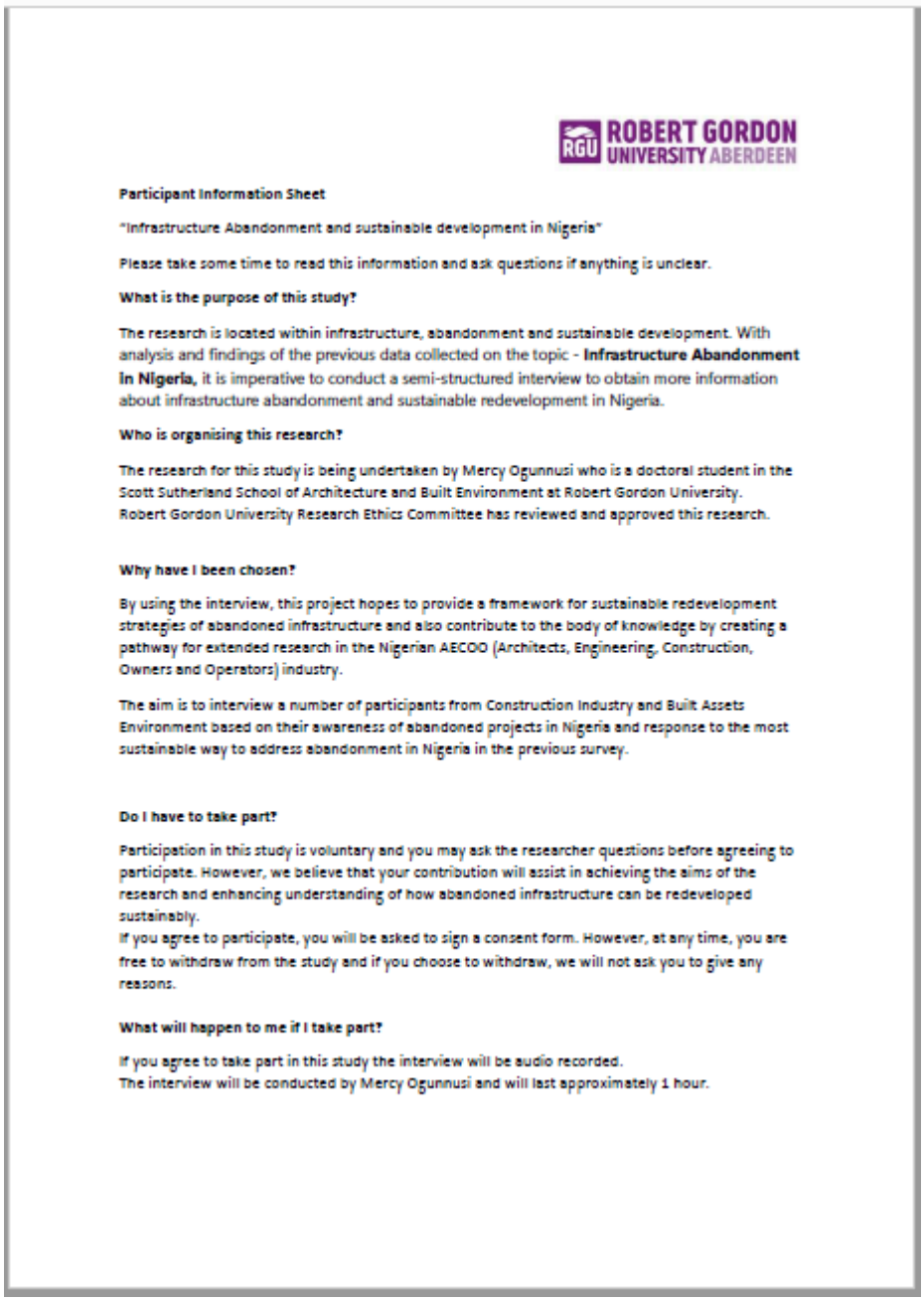
2) What are your thoughts about sustainable redevelopment?

3) Within the online survey, (Q15) You suggested that you felt “the best way (with sustainability in mind) to address the abandonment of infrastructure in Nigeria” was…….. Can you please explain your thinking behind this suggestion?

4) Were there any particular issues or criteria which you took into account? (e.g. finance, practicalities, impact)

5) Would the approach you suggest be used in other situations? E.g New Development.

APPENDIX 7: CONSENT FORM FOR THE SEMI-STRUCTURED INTERVIEW.



ROBERT GORDON UNIVERSITY ABERDEEN

Participant Information Sheet

"Infrastructure Abandonment and sustainable development in Nigeria"

Please take some time to read this information and ask questions if anything is unclear.

What is the purpose of this study?

The research is located within infrastructure, abandonment and sustainable development. With analysis and findings of the previous data collected on the topic - **Infrastructure Abandonment in Nigeria,** it is imperative to conduct a semi-structured interview to obtain more information about infrastructure abandonment and sustainable redevelopment in Nigeria.

Who is organising this research?

The research for this study is being undertaken by Mercy Ogunnusi who is a doctoral student in the Scott Sutherland School of Architecture and Built Environment at Robert Gordon University.
Robert Gordon University Research Ethics Committee has reviewed and approved this research.

Why have I been chosen?

By using the interview, this project hopes to provide a framework for sustainable redevelopment strategies of abandoned infrastructure and also contribute to the body of knowledge by creating a pathway for extended research in the Nigerian AECOO (Architects, Engineering, Construction, Owners and Operators) industry.

The aim is to interview a number of participants from Construction Industry and Built Assets Environment based on their awareness of abandoned projects in Nigeria and response to the most sustainable way to address abandonment in Nigeria in the previous survey.

Do I have to take part?

Participation in this study is voluntary and you may ask the researcher questions before agreeing to participate. However, we believe that your contribution will assist in achieving the aims of the research and enhancing understanding of how abandoned infrastructure can be redeveloped sustainably.
If you agree to participate, you will be asked to sign a consent form. However, at any time, you are free to withdraw from the study and if you choose to withdraw, we will not ask you to give any reasons.

What will happen to me if I take part?

If you agree to take part in this study the interview will be audio recorded.
The interview will be conducted by Mercy Ogunnusi and will last approximately 1 hour.

What are the possible benefits of participating?

Your participation will assist in achieving the aim and objectives of the research. The aim of the research is to investigate the sustainability of infrastructure projects in Nigeria in light of the arrays of abandoned projects and recommend possible remedies of sustainable development of abandoned infrastructure projects in Nigeria. To achieve this aim, there are five objectives and the most salient one relevant to this study is to develop a framework for sustainable redevelopment and recommend the best applicable sustainable solution to the decision makers in Nigeria.

What are the possible risks of taking part?

While we hope that your experience will be pleasant, and steps have been taken to minimise any risks to participants. At any time during the interview you can choose to withdraw.

How will my interview be used?

Your interview will be analysed along with other data gathered throughout the project to achieve the project aim and objectives.

On the consent form we will ask you to confirm that you are happy to assign your copyright for the interview to us, which means that you consent to the researcher using and quoting from your interview.

What will happen to the results of the project?

All the information that we collect about you during the course of the research will be kept strictly confidential. You will not be identified in any reports or publications and your name and other personal information will be anonymised.

What happens to the interviews collected during the study?

Interviews will be transcribed, recorded and stored digitally, managed by the researcher for the duration of the project. Only the researcher and supervisor will have access to the interviews and personal information.

What happens at the end of the project?

If you agree to participate in this project, the research will be written up as a thesis. You may request a summary of the research findings by contacting the researcher. On successful submission of the thesis, it will be deposited both in print and online at Robert Gordon University, to facilitate its use in further research. The digital online copy of the thesis will be deposited in the OpenAIR@RGU institutional repository and will be published with open access meaning that it will be available to all internet users.

What about use of the data in future research?

If you agree to participate in this project, the research may be used by other researchers and regulatory authorities for future research.

What should I do if I have any concerns or complaints?

If you have any concerns about the project, please speak to the researcher, who should acknowledge your concerns within ten (10) working days and give you an indication of how your concern will be addressed. If you remain unhappy or wish to make a formal complaint, please contact Professor Richard Laing, Scott Sutherland School of Architecture & Built Environment, r.laing@rgu.ac.uk

Fair Processing Statement

This information which you supply and that which may be collected a part of the project will be entered into a filing system or database and will only be accessed by the researcher and supervisor involved in the project. The information will be retained by Robert Gordon University and will only be used for the purpose of research, statistical and audit and possibly commercial purposes. By supplying this information, you are consenting to us storing your information for the purposes above. The information will be processed by us in accordance with the provisions of the appropriate data protection legislation. No identifiable data will be published.

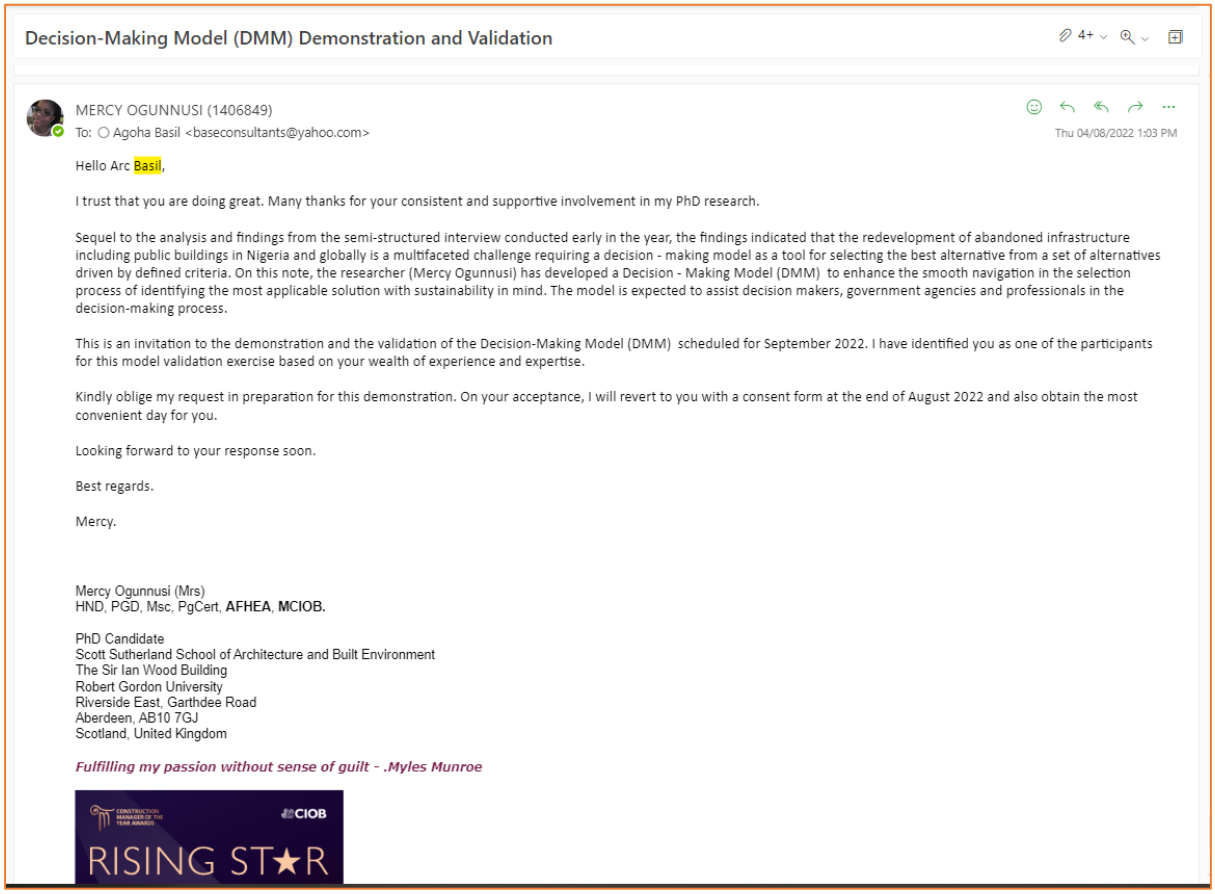
Title of Project: "Infrastructure Abandonment and sustainable development in Nigeria"

Researcher Name(s): Mercy Ogunnusi

	Please tick box
1. I confirm that I have read and understood the information sheet and have had the opportunity to ask questions	☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. In addition, should I not wish to answer any particular question or questions, I am free to decline.	☐
3. I understand that personal information collected about me, that can identify me, will not be shared beyond the study team	☐
4. I agree for this interview to be audio recorded. I understand that the audio recording made of this interview will be used only for analysis and that extracts from the interview, from which I would not be personally identified, may be used in any report or journal article as a result of the research. I understand that no other use will be made of the recording without my permission, and that no one outside the research team will be allowed access to the original recording.	☐
5. I agree to the use of anonymised quotes in published research	☐

.....	.....	.....
Name of Participant	Date	Signature
.....	.....	.....
Name of Researcher	Date	Signature

APPENDIX 8: CORRESPONDING BETWEEN STUDENT RESEARCHER AND ONE OF THE PARTICIPANTS FOR THE DMM



Decision-Making Model (DMM) Demonstration and Validation

MERCY OGUNNUSI (1406849)
To: Agoha Basil <baseconsultants@yahoo.com>
Thu 04/08/2022 1:03 PM

Hello Arc Basil,

I trust that you are doing great. Many thanks for your consistent and supportive involvement in my PhD research.

Sequel to the analysis and findings from the semi-structured interview conducted early in the year, the findings indicated that the redevelopment of abandoned infrastructure including public buildings in Nigeria and globally is a multifaceted challenge requiring a decision - making model as a tool for selecting the best alternative from a set of alternatives driven by defined criteria. On this note, the researcher (Mercy Ogunnusi) has developed a Decision - Making Model (DMM) to enhance the smooth navigation in the selection process of identifying the most applicable solution with sustainability in mind. The model is expected to assist decision makers, government agencies and professionals in the decision-making process.

This is an invitation to the demonstration and the validation of the Decision-Making Model (DMM) scheduled for September 2022. I have identified you as one of the participants for this model validation exercise based on your wealth of experience and expertise.

Kindly oblige my request in preparation for this demonstration. On your acceptance, I will revert to you with a consent form at the end of August 2022 and also obtain the most convenient day for you.

Looking forward to your response soon.

Best regards.

Mercy.

Mercy Ogunnusi (Mrs)
HND, PGD, Msc, PgCert, **AFHEA**, **MCIOB.**

PhD Candidate
Scott Sutherland School of Architecture and Built Environment
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Aberdeen, AB10 7GJ
Scotland, United Kingdom

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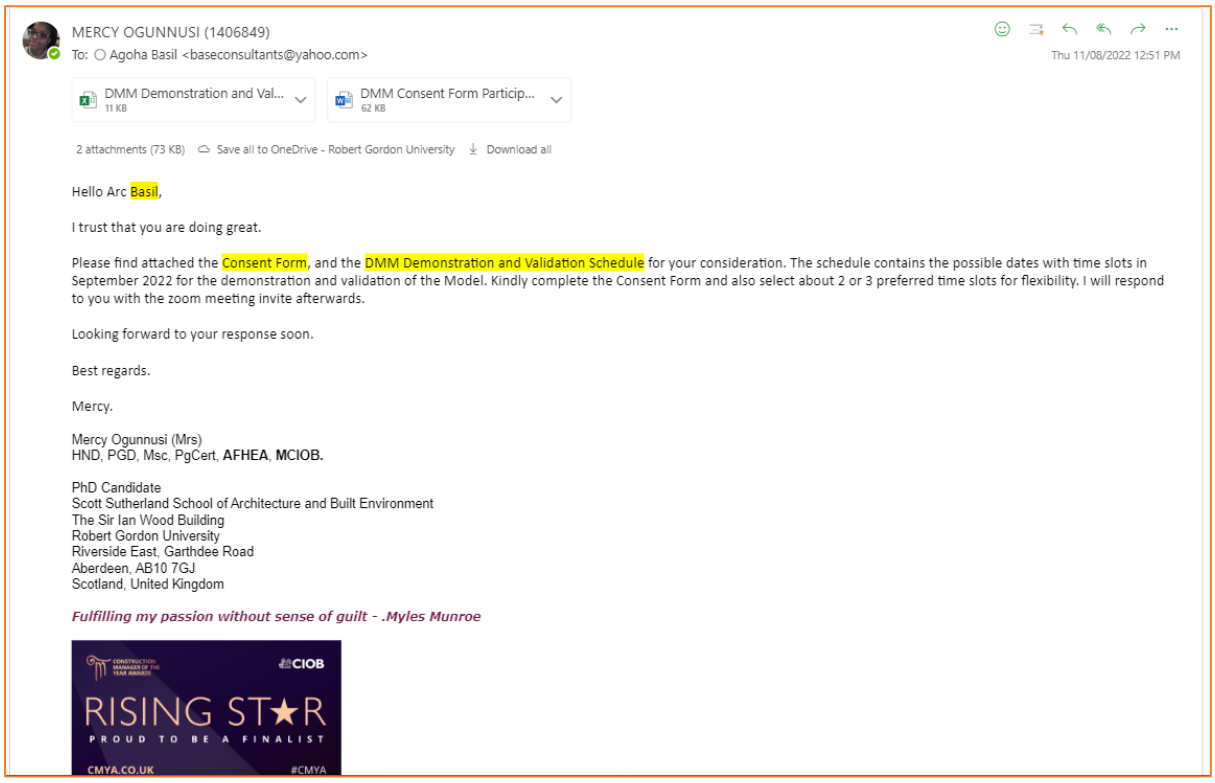

MERCY OGUNNUSI (1406849)
To: Agoha Basil <baseconsultants@yahoo.com>
Thu 11/08/2022 12:51 PM

DMM Demonstration and Val... 11 KB
DMM Consent Form Particip... 62 KB

2 attachments (73 KB) Save all to OneDrive - Robert Gordon University Download all

Hello Arc Basil,

I trust that you are doing great.

Please find attached the Consent Form, and the DMM Demonstration and Validation Schedule for your consideration. The schedule contains the possible dates with time slots in September 2022 for the demonstration and validation of the Model. Kindly complete the Consent Form and also select about 2 or 3 preferred time slots for flexibility. I will respond to you with the zoom meeting invite afterwards.

Looking forward to your response soon.

Best regards.

Mercy.

Mercy Ogunnusi (Mrs)
HND, PGD, Msc, PgCert, **AFHEA**, **MCIOB.**

PhD Candidate
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Scotland, United Kingdom

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APPENDIX 9: DMM DEMONSTRATION AND VALIDATION SCHEDULE SENT TO PARTICIPANTS.

DMM Demonstration and Validation Schedule

Week 1	Mon 5 Sept	Tues 6 Sept	Wed 7 Sept	Thurs 8 Sept	Fri 9 Sept
		10am-11am		10am-11am	
		12pm-1p		12pm-1pm	
		2pm-3pr		2pm-3pm	
	3pm-4pm	4pm-5pr		4pm-5pm	3pm-4pm
Week 2	**Mon 12 Sept**	**Tues 13 Sept**		**Thurs 15 Sept**	**Fri 16 Sept**
	10am-11am				10am-11am
	12pm-1pm				12pm-1pm
	2pm-3pm				2pm-3pm
	4pm-5pm	3pm-4pr		3pm-4pm	4pm-5pm
Week 3	**Mon 19 Sept**	**Tues 20 Sept**		**Thurs 22 Sept**	**Fri 23 Sept**
		10am-11a		10am-11am	
		12pm-1p		12pm-1pm	
		2pm-3pr		2pm-3pm	
	3pm-4pm	4pm-5pr		4pm-5pm	3pm-4pm
Week 4	**Mon 26 Sept**	**Tues 27 Sept**		**Thurs 29 Sept**	**Fri 30 Sept**
	10am-11am	10am-11am	10am-11am	10am-11am	10am-11am
	12pm-1pm	12pm-1pm	12pm-1pm	12pm-1pm	12pm-1pm
	2pm-3pm	2pm-3pm	2pm-3pm	2pm-3pm	2pm-3pm
	4pm-5pm	4pm-5pm	4pm-5pm	4pm-5pm	4pm-5pm

ration ar

Tues 6 Sept
x10am-11am
12pm-1pm
2pm-3pm
4pm-5pm
Tues 13 Sept
3pm-4pm
Tues 20 Sept
x10am-11am

APPENDIX 10: CONFIRMATION FOR ACCEPTANCE OF THE INVITATION TO ATTEND THE DMM.

Decision-Making Model (DMM) Demonstration and Validation

From: Agoha Basil <baseconsultants@yahoo.com>

Sent: 05 August 2022 3:24 PM

To: MERCY OGUNNUSI (1406849) <m.o.ogunnusi@rgu.ac.uk>

Subject: Re: Decision-Making Model (DMM) Demonstration and Validation

Good day. Invitation accepted.Good to hear from you. Greetings to your family.
Thanks.
Basil O.Agoha

Sent
from Yahoo Mail on Android

APPENDIX 11: WEE REMINDERS FOR THE MEETING

Decision-Making Model (DMM) Demonstration and Validation

MERCY OGUNNUSI (1406849)
To: Agoha Basil <baseconsultants@yahoo.com>
Sun 11/09/2022 2:30 PM

Hello Arc Basil,

I trust that you are doing great.

This is just a wee reminder of the ZOOM meeting that is scheduled for tomorrow Monday 11th September 2022 at 10am Nigerian Time.

Kindly reconfirm your availability.

Looking forward to seeing you tomorrow.

Regards.

Mercy.

Mercy Ogunnusi (Mrs)
HND, PGD, Msc, PgCert, **AFHEA**, **MCIOB.**
IEMA Award Winner - SEEDS Conference 2022.

PhD Candidate
Scott Sutherland School of Architecture and Built Environment
The Sir Ian Wood Building
Robert Gordon University
Riverside East, Garthdee Road
Aberdeen, AB10 7GJ
Scotland, United Kingdom

Fulfilling my passion without sense of guilt - .Myles Munroe

Mercy Ogunnusi PgCert, MSc., AFHEA, MCIOB. - Google Scholar

(2) Mercy Oluyomi Ogunnusi, Msc, PgCert, AFHEA, MCIOB | LinkedIn

AB
Agoha Basil <baseconsultants@yahoo.com>
To: MERCY OGUNNUSI (1406849)
Sun 11/09/2022 8:32 PM

Mercy UK Time.xlsx
11 KB

> Noted. Tommorrow Monday is September 12 by 10am.
> Thanks
> Basil O.Agoha

APPENDIX 12: CONSENT FORM FOR THE DMM DEMONSTRATION

ROBERT GORDON UNIVERSITY ABERDEEN

Participant Information Sheet

"Decision Making Model (DMM) for sustainable redevelopment of abandoned infrastructure in Nigeria. The Case study – The Government Federal Secretariat".

This is a list of FAQs typically asked by potential participants, but the recipient may have other questions. If so, contact the researcher at m.o.ogunnusi@rgu.ac.uk.

What is the purpose of this study?

The research is located within infrastructure abandonment, sustainable development, and decision - making process. With analysis and findings of the previous data collected on the topic **- Infrastructure Abandonment and Sustainable Development in Nigeria,** through a semi-structured interview, the redevelopment of the public buildings such as Federal Secretariat is a multifaceted challenge requiring a decision-making model as a tool to select the best alternative from a set of alternatives. The model is expected to assist the decision makers in the government, agencies, and the professionals in the industry in the decision-making process.

Some questions that you may be asked after the demonstration of the model include, Was the tool easy for use? Was it easy to navigate from one worksheet to another? Was the information in the Decision-Making Model page adequate?

As a potential user of this model, you are expected to indicate your interest and the zoom link for the demonstration of the model will be forwarded to you for the testing and the validation of the model.

The recorded semi-structured interview will follow to obtain your feedback and more information on the flexibility and the functionality of the model, The interview will be transcribed for analysis.

Who is organising this research?

The research for this study is being undertaken by Mercy Ogunnusi who is a doctoral student in the Scott Sutherland School of Architecture and Built Environment at Robert Gordon University. Robert Gordon University Research Ethics Committee has reviewed and approved this research.

Why have I been chosen?

Your participation and views in this study would be immensely appreciated. By demonstrating the model during the interview, this project hopes to provide a sustainable framework for redevelopment strategies of abandoned infrastructure and contribute to the body of knowledge by creating a pathway for extended research in the Nigerian AECOO (Architects, Engineering, Construction, Owners and Operators) industry.

Do I have to take part?

Participation in this study is voluntary and you may ask the researcher questions before agreeing to participate. However, we believe that your contribution will assist in achieving the aims of the research and enhancing understanding of how to facilitate decision making in sustainable redevelopment of abandoned.
If you agree to participate, you will be asked to sign a consent form. However, at any time, you are

free to withdraw from the study and if you choose to withdraw, we will not ask you to give any reasons.

What will happen to me if I take part?

If you agree to take part in this study the interview will be audio recorded.
The interview will be conducted by Mercy Ogunnusi and will last approximately 40-50minutes.

What are the possible benefits of participating?

Your participation will assist in achieving the aim and objectives of the research. The aim of the research is to demonstrate a decision-making model as an applicable and possible solution for sustainable development of abandoned infrastructure projects in Nigeria.

What are the possible risks of taking part?

While we hope that your experience will be pleasant, and steps have been taken to minimise any risks to participants. At any time during the interview, you can choose to withdraw.

How will my interview be used?

Your interview will be analysed along with other data gathered throughout the project to achieve the project aim and objectives.

On the consent form we will ask you to confirm that you are happy to assign your copyright for the interview to us, which means that you consent to the researcher using and quoting from your interview.

What will happen to the results of the project?

All the information that we collect about you during the course of the research will be kept strictly confidential. You will not be identified in any reports or publications and your name and other personal information will be anonymised.

What happens to the interviews collected during the study?

Interviews will be transcribed, recorded and stored digitally, managed by the researcher for the duration of the project. Only the researcher and supervisor will have access to the interviews and personal information.

What happens at the end of the project?

If you agree to participate in this project, the research will be written up as a thesis. You may request a summary of the research findings by contacting the researcher. On successful submission of the thesis, it will be deposited both in print and online at Robert Gordon University, to facilitate its use in further research. The digital online copy of the thesis will be deposited in the OpenAIR@RGU institutional repository and will be published with open access meaning that it will be available to all internet users.

What about use of the data in future research?

If you agree to participate in this project, the research may be used by other researchers and regulatory authorities for future research.

What should I do if I have any concerns or complaints?

If you have any concerns about the project, please speak to the researcher, who should acknowledge your concerns within ten (10) working days and give you an indication of how your concern will be addressed. If you remain unhappy or wish to make a formal complaint, please contact Dr Huda Salman, Scott Sutherland School of Architecture & Built Environment, h.salman@rgu.ac.uk

Fair Processing Statement

This information which you supply and that which may be collected a part of the project will be entered into a filing system or database and will only be accessed by the researcher and supervisor involved in the project. The information will be retained by Robert Gordon University and will only be used for the purpose of research, statistical and audit and possibly commercial purposes. By supplying this information, you are consenting to us storing your information for the purposes above. The information will be processed by us in accordance with the provisions of the appropriate data protection legislation. No identifiable data will be published.

Title of Project: "Decision Making Model (DMM) for sustainable redevelopment of abandoned infrastructure in Nigeria. The Case study – The Federal Secretariat".

Researcher Name(s): Mercy Ogunnusi

	Please tick box
1. I confirm that I have read and understood the information sheet and have had the opportunity to ask questions	☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. In addition, should I not wish to answer any particular question or questions, I am free to decline.	☐
3. I understand that personal information collected about me, that can identify me, will not be shared beyond the study team	☐
4. I agree for this interview to be audio recorded. I understand that the audio recording made of this interview will be used only for analysis and that extracts from the interview, from which I would not be personally identified, may be used in any report or journal article as a result of the research. I understand that no other use will be made of	☐

the recording without my permission, and that no one outside the research team will be allowed access to the original recording.

5. "I understand that it will not be possible to remove my data from the project once it has been anonymised and forms part of the data set." ☐

6. I agree to the use of anonymised quotes in published research ☐

7. I agree to take part in this study ☐

.....	.....	.....
Name of Participant	Date	Signature

.....	.....	.....
Name of Researcher	Date	Signature

APPENDIX 13: USER GUIDE FOR THE MODEL DEMONSTRATION

User Guide

Decision Making Model for the Sustainable Redevelopment of Abandoned Infrastructure in Nigeria

Design By: Mercy Ogunnusi AFHEA, MCIOB, PhD Candidate

Table of Content

List of Figures

A Decision-Making Model for the Sustainable Redevelopment of Abandoned Infrastructure in Nigeria.

1. Introduction

The Decision-Making Model (DMM) is a software-based decision-making system conceptualised to enhance the decision-making process for the sustainable redevelopment of abandoned infrastructure in Nigeria.

The DMM is designed for application by the built environment professionals and construction practitioners in general. The DMM employs the Microsoft Excel software platform and is backed by uploaded guidance documents by direct web links through an operating internet connectivity.

The Microsoft Excel Graphical User Interface protected with macr**o**, however, contained some open cells (in Yellow) for user manipulation. The DMM is created by a few sequenced worksheets in the following format:

- Cover Page
- Maps and Guidance
- Project Information
- Sustainability Initiatives
- Decision Making Model
- Criteria Weightage
- Associated Guidance
- Survey

This User Guide describes the model set-up in the same precedent as presented in the work sheet are presented as above. A case study was used for detailed demonstration purposes of the model set-up. The project (Case Study) is the Federal Government Secretariat, Lagos State, Nigeria abandoned due to relocation of the seat of the Federal Government of Nigeria from Lagos State to the Federal Capital Territory (FCT) Abuja in 1991. Although, the decision-making procedures is a guide not just only for the redevelopment process, but for any decision-making process within the Nigerian construction industry.

2. Cover Page

The “Show Tabs” is enabled to show the Ribbon tabs only. The Gridlines and Formula Bars were also disabled to enable the Graphic User Interface (GUI).

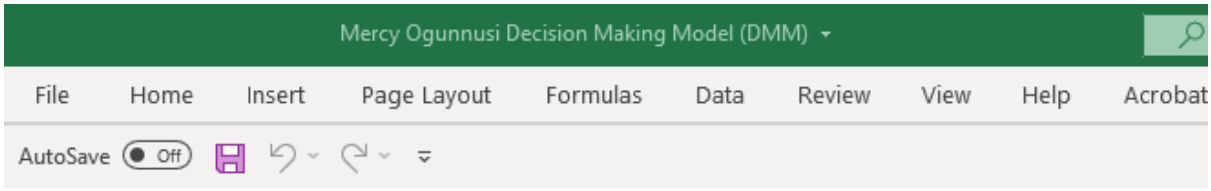


Figure 1: Show Tab Commands

The cover page will emerge (Figure 2). The DMM is compatible with Microsoft (MS) Windows operating systems. The contents of the “cover page” sheet include a MS page of the brief introduction of the model. The pictorial view of the project (case study) was also included for graphical illustration.

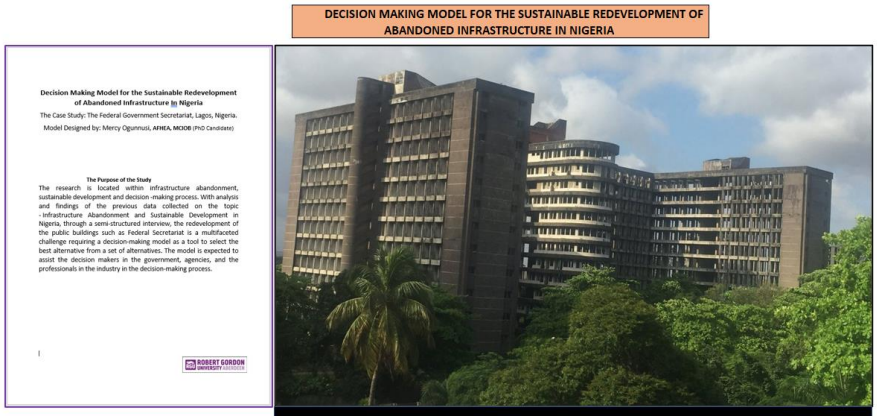
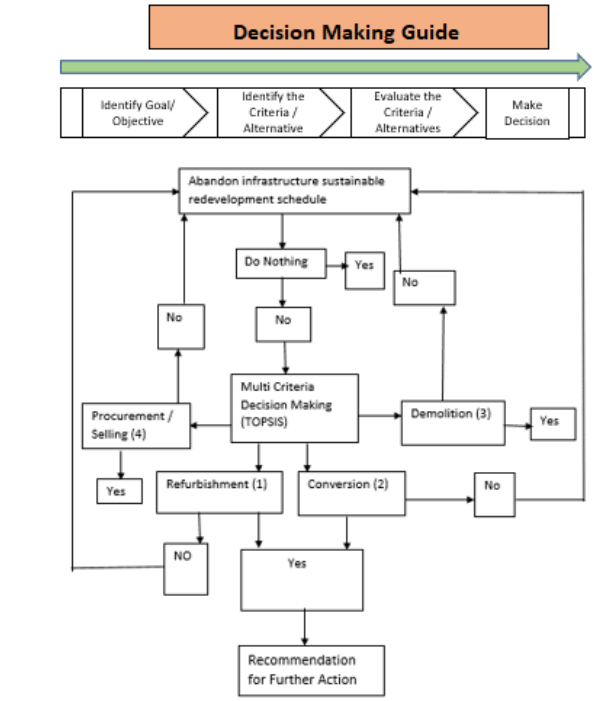


Figure 2: Cover Page

3. Maps and Guidance

This illustrates and describes the broader decision-making procedure including the step-by-step processes. The map and guidance also include the generic flow diagram of discussion making routes. The screenshots used e.g “Maps and Guidance are imported from the Power point of MS operating systems. The only difference is that format for pasting the maps and guidance is a picture version that is not editable.



Note:

1) **Refurbishing** the original building for their historical purposes?
2) **Converting** the buildings into apartment housing and preserving the architectural -urban expression?
3) **Demolition** of the building and the implementation of a new design?
4) **Procurement / Selling** of the building to private sector / entities or investors?

Figure 3: Decision Making Guide

Project Information

The project information page is a section that provides all the necessary information about the project. It also contains the navigation buttons to the other worksheets / model set-up within the GUI. In addition to the navigation buttons as indicated in figure 5, the bottom tab of the excel worksheet can also be used for the same navigation purpose. Each sheet contains the navigation buttons for ease of steering from one sheet to another

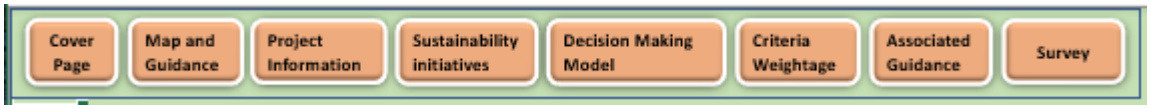


Figure 4: Navigation Tabs

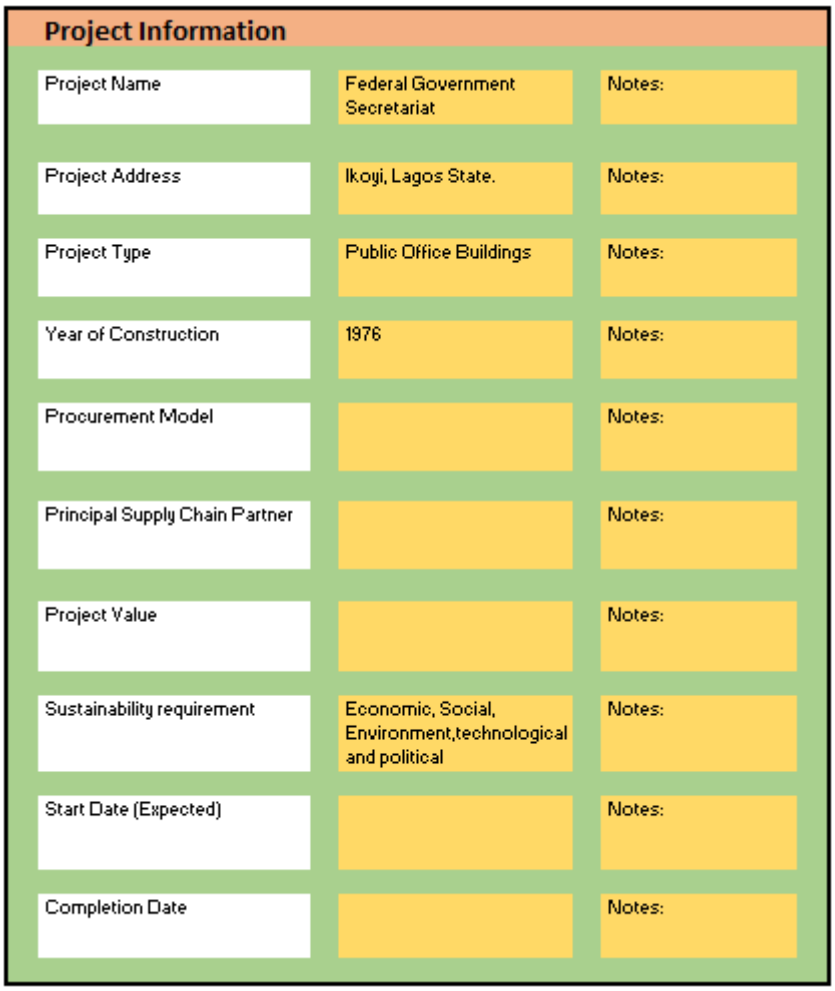


Figure 5: Project Information

4. Sustainability initiatives

The aim of the sustainability initiatives worksheet is intended as a support memoire for the model user/decision maker on the most commonly discussed sustainable issues such as:

- Social
- Economic

- Environmental
- Technical
- Political
- Functional
- Legal

The worksheet also serves as collection point for all the items required in the drop-down menu lists for the scale of relevance, attributes, criteria and alternatives. The set of criteria and alternatives embedded in the sustainability attributes worksheets are selected into the DMM with the use of the dropdown menu. The set of alternatives are the possible redevelopment strategies that could be considered by the model Users or the decision makers. The criteria are the sustainability issues that can be considered under the multi-criteria decision making.

Sustainability Attributes	Criteria	Alternatives Guidance
Social	Creation of employment opportunities	**Refurbishing** the original building for their historical purposes?
Economic	Investments	**Converting** the buildings into apartment housing and preserving the architectural - urban expression?
	Profitability	**Demolition** of the building and the implementation of a new design?
Environmental	Preservation of historical value	**Procurement / Selling** of the building to private sector / entities or investors?
	Waste generation / prevention	
	CO2 emissions	
	Energy efficiency	
Technical	Project Preparation and coordination	
	Structural integrity and foundation	
Political	Government regulations and policies	
	Change in government	
Functional	Alternative use	
	Change of use	
	material changes	
	Cultural purposes	
	Need assessment	
Legal	Security	
	Safety	
	Litigation	

Figure 6: Attributes, Criteria and Alternatives

6. Decision Making Model

The decision-making model consist of the scale of relevance, the tables that where the computation of the comparison of the criteria and alternatives are applied with the aid of the formula. The decision maker/ model user needs to click the drop-down menu in each cell to select the appropriate criteria or alternatives as the case may be. The criteria and the alternative can be updated in the “Sustainability Initiatives” worksheet and as long as it is updated in the drop-down menu, it will appear when needed in the DMM.

Table 1

Alternative Guidances	Creation of employment opportunities	Investments	Profitability	Preservation of historical value	Waste generation / prevention	CO2 emissions	Energy efficiency	Project Preparation and	Structural integrity and foundation	Government regulations and policies
Refurbishing the original building for their historical purposes?										
Converting the buildings into apartment housing and preserving the architectural - urban expression?										
Demolition of the building and the implementation of a new design?										
Procurement / Selling of the building to private sector / entities or investors?										
Total	0	0	0	0	0	0	0	0	0	0

Legend	
	Criteria
	Alternatives
	Input cells

Figure 7: Decision Making Sheet

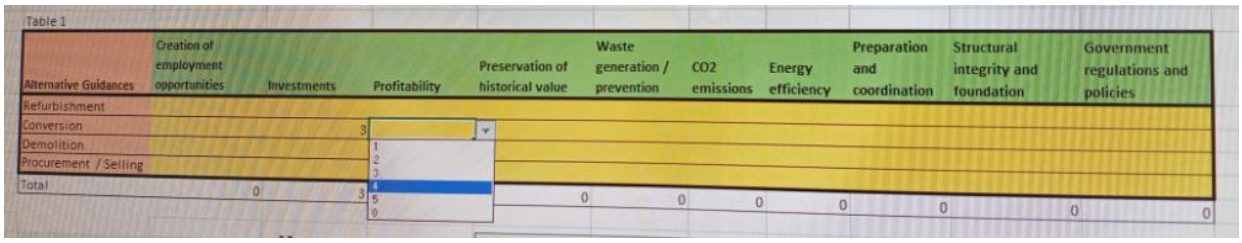


Figure 8: Decision Making Sheets with Drop-Down Menu.

The worksheet is formatted with the formulas and the calculations. At the end of criteria and alternatives comparison with the aid of the scale of relevance, the "performance score" and the rank will be updated to present the selection of the best sustainable solution. The selection can be done individually or collectively as a focus group. If done individually, a member of the decision makers team will collate the performance score, determine the average ranking for each alternative.

Si+	Si-	Pi	Rank
0.0000	#DIV/0!	#DIV/0!	
#DIV/0!	#DIV/0!	#DIV/0!	
#DIV/0!	#DIV/0!	#DIV/0!	
#DIV/0!	#DIV/0!	#DIV/0!	

Figure 9: Performance Score and Ranking

Relevance scale
1- Least relevance
2 - Low relevance
3 - Moderate relevance
4 - High relevance
5 - Highest relevance

Figure 10: Scale of Relevance

The summary instruction for using the Decision-Making Model Framework is expounded below:

1)With the dropdown menu, the User select all the criteria and alternatives needed for the computation.
2) The reference scale is located on the GUI and is identified as the Relevance Scale.
3)The weightage is Step 3 is calculated as Wj = 1/n where n= number of the criteria.

4)Through a process of deliberation and consensus, the model user selects the appropriate scale of relevance for each criterion by means of drop-down menus.
5)The total score will automatically update.

7. Criteria Weightage

The criteria weight is Wj = 1/n =1/10 =0.1, where "n" is the number of the criteria. This method is applied in the absence of information or when the information is not sufficient or available to attain a decision.

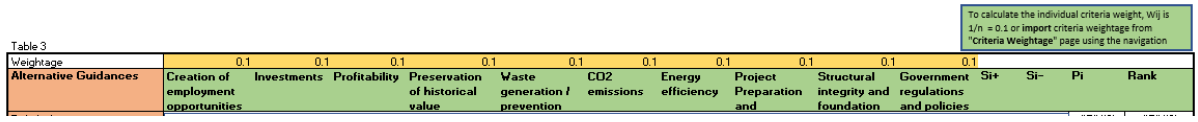


Figure 11: Criteria Weight (Option 1)

Another method to determine the criteria weight is through, Analytical Hierarchical Process, Entropy method etc. The Criteria Weightage sheet provides already formatted calculation for another criteria weight. The figures for each criteria provided that the computation is 100% can be transferred to the DMM sheet. This will or may change the performance score and the ranking.

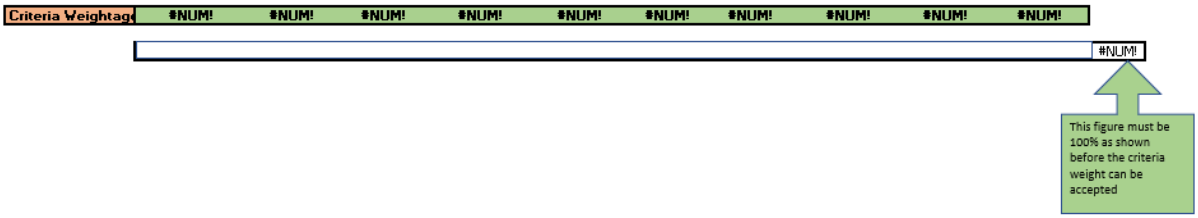


Figure 12: Criteria Weight (Option 2)

8. Associated Guidance

This worksheet is the collection of journals, reports and regulation manuals that relates to or are relevant to the decision-making procedure. In the alphabetical order, the guidance is aimed to direct and enhance the criteria selection procedure.

Associated Guidance	Links
Assessment of Building Redevelopment Possibilities Using MCDM and BIM Techniques	Click Here
Selection of Most Suitable Contractor By Using MCDM Techniques	Click Here
A Survey on Fuzzy MCDM Methods Methods and Its Application	Click Here
An Infrastructure Action Plan for Nigeria: Closing the Infrastructure Gap and Accelerating Economic Transformation	Click Here
Managing Infrastructure Assets for Sustainable Development	Click Here
Infrastructure Concession Regulatory Commission Nigeria: Draft PPP Manual for Nigeria 2017	Click Here
Social Sustainability : Concepts and Benchmarks	Click Here

Figure 13: Associated Guidance

Next Steps

Upon completion of the decision-making process as described in the previous section, the user may return to the “Project Information” Sheet (Figure 14) to input the final decision made.

9. Survey for Effectiveness and of the platform

	Effectiveness for Intended Use	
1	Within the Project Information section, there was sufficient information to enhance decision making process	
2	The information provided on the project Information Section page is adequate.	
3	The *Map and Guidance* page is valuable to the process	
4	The Sustainability Initiatives page is beneficial in enabling the process of selecting the relevant attributes, criteria and alternatives	
5	The Associated Guidance page is useful for decision making	
6	The Decision Making Model page facilitate adequate comparisons to be made between the selected alternatives and the criteria.	
7	The Decision Making Model page enables the adequate performance rating to be applied to the most suitable options	
8	The model is beneficial to the sustainable redevelopment of abandoned infrastructure in Nigeria	
9	The model is valuable in supporting me with the selection of the preffered option	
10	The varieties of topics including the criteria and alternatives discuss in the model is sufficient	
11	The Model is valuable in ascertaining best value for money from the identified options	

Figure 14: Survey

GUI Preference / Ranking Charts

The criteria to alternative chart are illustrated in the context of the case study. The DMM process is scored with the comparison in the colour coding. The summary of the criterion coding is also provided in the chart.