WHOLE LIFE COSTING PRACTICES EMPLOYED BY DESIGN TEAMS OF BUILDING CONSTRUCTION PROJECTS IN ABUJA, NIGERIA

ABSTRACT

The Bureau for Public Procurement (BPP), which was established by the Public Procurement Act of 2006 to oversee the procurement of public projects through inter-alia the application of Value for money (V*f*M) practices, has admitted that "*...lowest initial price may not equate to lowest cost over the operating life of the item procured*". The application of Whole Life Costing (WLC) in building projects is still limited and there is a need to explore the application of WLC among members of the design team. This study aimed to evaluate WLC practice by design team members of housing projects with a view to enhancing value for money spent on housing. The objectives of the study include determining the extent to which WLC has been practiced, and examining the drivers and barriers of the use of WLC by design teams. The study adopted a quantitative research design that was based the use of questionnaires. A convenience sample of relevant professionals in construction firms who could be accessed electronically was built up through a snowballing approach, which eventually yielded a total of 63 professionals. The data thus gathered was analyzed using descriptive statistical method (Mean Item Score and Standard Deviation) and the results were presented using tables and charts. The study found that construction professionals tend to consider only construction cost as representative of overall project costs, often to the exclusion of other important types of costs. Availability of data and clients specifically requesting the use of WLC are two key factors that drive WLC use. Use of WLC is however hindered by absence of WLC standards, use of WLC is non-mandatory for public projects, and insufficient end-user training. This study has recommended urgent up-skilling of construction professionals for WLC use through Continuing Professional Development (CPD) seminars, redesign of tertiary education construction curricula, and amendment of existing laws that currently ignore WLC. These can only be achieved through joint effort of the Bureau of Public Procurement (BPP), trade associations such as the NIQS and statutory bodies such as the QSRBN, COREN and CORBON. Further research in this area could be carried out on the effect of type of project on the practice of WLC in building construction projects.

HAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Globally, the construction industry plays a vital role in the economy of both developing and developed nations. According to Abdulwahab (2015), the construction industry represents about 60% of the Nation's Capital Investment and 30 % of the Gross Domestic Product (G.D.P). Furthermore, the construction industry is said to have contributed about half of the Total Stock of Fixed Capital Investment (T.S.F.C.I) in Nigeria economy. The construction sector likewise gives the framework that upholds different areas of the economy.

The Nigerian construction industry (NCI) had been portrayed as a 'sleeping giant' as far as administration conveyance and ability to fulfil the necessities of its clients (Kolo & Ibrahim, 2010). The Nigeria industry additionally produces work openings which place it second to the public authority in employment of labour (Abdulwahab, 2015). At the point when the construction industry was blasting in the mid 1970's the country's economy experienced comparable impacts during that period. Notwithstanding, from early to mid-1980, the industry experienced a jolt and its effect was felt in all spheres of national life (Abdulwahab, 2015).

In endeavouring to upgrade good government in public procurement, the Nigerian government charged the World Bank as a team for certain Nigerian Private Sector Specialists to attempt investigations of its monetary frameworks and general acquirement related exercises. The investigation created the Country Procurement Assessment Report (CPAR) 2000 which prompted the birth to the Public Procurement Act (PPA). The Act set up the Bureau for Public Procurement (BPP) to regulate and set guidelines for the

acquirement of public procurement projects through inter alia the use of Value for money (VfM) standard and principles.

The BPP, in its public procurement manual, clarified that "value may suggest something other than price, quality issues additionally should be tended to and lowest initial price may not equate to lowest cost over the operating life of the item procured". Although the document did not make reference to whole life cost (WLC) as an idea for accomplishing VfM, it recognized that the initial price probably would not mean VfM. According to Aliyu (2017), VfM is characterized as "the the optimum combination of whole life cost (WLC) and quality to meet the client's requirement". Consequently for VfM to be accomplished the whole life cost of the facility should be considered.

WLC theory has been grounded but has not gotten wide practical application. This is because of the issues of information shortage, uncertainty and the need for evaluating non-money related components Kishk *et al.* (2013). Application of WLC among team members is limited; in spite of the fact of increasing research patterns are expanding here (Dallas, 2006). It is with respect to this that models were created by different establishments and professional bodies to overcome the previously mentioned issues (Bryman & Bell, 2008).

Research conducted in Nigeria in the area of WLC incorporate that of Ibrahim *et al.* (2010) which recognized the qualities of WLC information in the Nigerian construction industry to incorporate non-formal documentation of sources, accessibility, dependability and consistency of WLC information just as a standard methodology for the assortment, examination, approval and introduction of WLC information. Bala *et al*. (2018) built up a model to conquer the issue of information shortage and vulnerability in the Nigerian development industry. Bala *et al. (*2018) further tried the proficiency of the model created and discovered that it was a solid instrument. Others include those of Ityobee (2016) and

that of Bimba (2018). Ebunoluwa (2016) researched the use of WLC in building projects in Nigeria, while Bimba (2008) investigated the use of WLC in the design of hotel reception.

The Nigerian based examination in WLC made fantastic disclosures on the attributes of the information just as giving the answer for the issue of information vulnerability and shortage, however they exist a hole as WLC rehearsed utilized by configuration group of building constructions.

1.2 Statement of the Problem

Globally the practices of WLC towards the achievement of VfM have been streamlined through the provision of definitive guides and standards. An example is the Office of Government Commerce guide 7 of the UK, the green Book-HM treasury (UK) launched by HM Treasury (2013) and BS ISO 15686 1 to 5.

The BPP produced two documents to serve as a guide in the procurement of public projects which are the public procurement manual and the Standard Bidding Document (SBD). These two documents addressed issues regarding transparency and the selection of the lowest evaluated tender but no mention was made of WLC concept therein. The non inclusion of WLC concept in the BPP guides assumed that there are established practices for WLC in Nigeria. The absence of standard procedures to set out how V*f*M can be achieved through WLC of the project would lead to varied understanding of the concept as well as varied methods in the practices. These two factors are barriers to a streamlined WLC practice as identified by Ebunoluwa (2016), Rum & Akasah, (2011), (Chirigwi *et al*., 2010).

Ityobee (2016) found out that the few firms that carried out WLC in Nigeria do it based on the client request; even though the type of client was not indicated. Furthermore, the research was conducted prior to the enactment of the PPA. Consequently, the non-

inclusion of guide for WLC implementation towards the attainment of V*f*M in public procurement in Nigeria since the enactment of PPA makes the study of the state of the art of WLC application in the procurement of public buildings a necessity in support of this, Aliyu (2017) found out that there is a need to explore the understanding and practice of WLC among the design team.

1.3 Research Questions

The following questions were answered in order to address the problem of the study

i. To what extent Whole Life Costing been practiced by design teams of building construction projects in Abuja, Nigeria?
ii. What are the factors responsible for driving the practice of Whole Life Costing by design teams of building construction projects?
iii. What are the barriers hindering the use of Whole Life Costing by design teams of building construction projects?

1.4 Aim and Objectives

The aim of this study is to evaluate the practice of WLC by members of design teams of building construction projects in Abuja, Nigeria with a view to enhancing value for money spent on housing.

The objectives of the study are to:

i. Determine the extent to which WLC has been practiced by design teams of building construction projects in Abuja, Nigeria.
ii. Examine the factors responsible for driving the practice of WLC of building construction projects.
iii. Examine the barriers hindering the use of WLC by design teams of building construction projects.

1.5 The Need for the Study

Part of the objectives of the BPP is *"*ensuring the application of fair, competitive, transparent, value-for-money standards and practices for the procurement and disposal of public assets and services*"* (PPA, 2019*).* This statement implies that it is required for every public building project to be procured in a manner that will ensure that V*f*M (which has been well-linked with WLC practices among design team). Previous study by Olubodun *et al.* (2010) has identified client demand for WLC practices as the key motivation for undertaking WLC. Olubodun *et al.* (2010) further revealed that the lack of understanding and the absence of a standardized methodology for the practice are barriers to the implementation of WLC in the UK (Olubodun *et al.,* 2010).

In Nigeria, the current knowledge base and skills of design team members in implementing WLC remains unknown and non-provision of guides by the BPP could lead to varied understanding and application of WLC technique. Thus, this study seeks to investigate the state of the art with respect to WLC practice among the design team members in public building projects towards the achievement of V*f*M.

1.6 Scope of the Study

This research considered issues on implementation of WLC by members of design teams of building construction projects with a view to enhancing value for money spent on building projects in Abuja. The scope is limited to design teams in Abuja because of the concentration of ongoing projects in the location, as well as the fact that the researcher is familiar with this location. Data for the study was collected within 2020, from construction professionals only.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 The Construction Industry

The construction industry is an important industry worldwide. The construction industry generally defined as a sector of the economy, playing an important role in the economic growth of the country but it faces many challenges currently that lead to affect project goal and steady growth of the economy. The construction industry has characteristics that separately are share by other industries but in combination appear in construction alone (Omole, 2000)

The construction industry is divided into building, civil and heavy engineering subsectors (Oforeh, 2017). The industry has diverse interests, the principal interest or actors are the Client, the Consultants and the Contractors. The Client is the most important member of the construction team as he is the initiator and provides funds for the construction. There are two major clients: the public and the private client.

The consultants comprise of professionals from various disciplines and competencies such as Quantity Surveyor, Architect and Engineers making up the project design team. The consultants' most important consideration is the codt implication of the client's requirement as it is essential to see that projects are contained within the client's budget and cost foreecasts. Accurate cost analysis and control is one of the necessary services the client requires from the consultants Olubodun *et al.,* (2010).

The Contractor has the major task of assembling and allocating the resources of labour, equipment and materials to the project in order to achieve complection at maximum efficiency in terms of time, quality and cost (Olubodun, 2010).

2.1.1 The Nigerian Construction Industry

The construction industry plays vital role in the economic activities of most developing countries including Nigeria. Nigeria's Construction Industry grew by 8 percent from the previous quarter, according to the latest Q2 GDP figures released by the National Bureau of Statists (NBS). The Sector's GDP has been improving steadily in the last four quarters (Q3 2016 to Q2 2017). From a drop of 2 percent in Q3 2016 from the prior quarter, the sector bounced back in Q4 2016 recording the growth in normal GDP of 19 percent over the previous period and increase of 15 percent in Q1 2017.

Dantata (2008) thought that in Nigeria it is protected to say that the predominant client for development exercises is the public authority through its numerous services and offices. The private client incorporates people, global bodies, enormous and medium privately owned businesses. The Nigerian construction industry as expressed by Dantata (2008) is partitioned into two significant gatherings; the casual and the formal. The conventional area dissimilar to the casual one is a coordinated design if development exercises in which exercises are led under set guidelines and guidelines remembering adherence to public laws for work and acquirement.

Ibrahim (2008) expressed procurement is considered as key to execution improvement in the construction industry. Thus a successful procurement is crucial to the improvement of the construction industry in Nigeria.

2.1.2 Public Building

All types of governmental offices are considered Public buildings. Public buildings generally serve the purpose of providing a service to the public, men of this service are provided free to residents. These include public schools, libraries, courthouses and post offices (Hashim, 2019).

Procurement is defined as the process of buying goods, works and services (FGN, 2017). The PPA's definition seems to be concerned with procurement a proceeding which is limited to the initiation of the process of effecting procurement up to the award of a procurement contract. In the infrastructure sector, it determines the overall framework and structure of responsibilities and authorities for guiding participants with the development process (Adogbo *et al*., 2010). Procurement encompasses all stages from the identification of the need of the product to the delivery and subsequent maintenance of the asset. (Ibrahim, 2008). The procurement method chosen to provide the asset that should effectively solve the time, cost and quality paradigm (highest quality, at lowest price, in shortest time) which now has been overtaken by the value for money paradigm (Hackett *et al.*, 2007). For construction projects, procurement can be categorised into pre and post contract stages with the involvement of the design and construction teams (Ibrahim, 2003; Aqua Group, 2007).

Public procurement policies have five key concerns as identified in the PPA (2019) are; that the purchase of items should be economic and efficient. Second, use of public funds should purchase only items needed for national development. Third, purchases should secure best value by giving all qualified bidders equal opportunity to compete for contracts. Fourth, procurement process should encourage the development of local contractors and manufacturers. Finally, public procurement should ensure the transparency and accountability in the public procurement process.

Subsequent to he emergence of the general contracting firms and the establishment of independent consultants, experts have observed that the traditional method of procurement became a standard practice in public secor procurement and particularly in the building industry over many years ago, though the method has been severely criticized for its inadequacies Love *et al.* (1998). Under the traditional procurement

method, independent multi-discipline consultants on behalf of the client organization undertake the pre and post contract management of projects to completion (Onwusonye, 2005). This is characterized by the separation of the project development (design and cost processes) from project implementation (construction and control process) Hughes *et al*. (2004), where full documentation is required before the contractor can be invited to tender for carrying out the work.

2.2 Whole Life Costing (WLC)

At the start building designs were aimed at minimising initial construction costs alone, but as time went on, around 1930s many building users began to discover that the running costs, of buildings began to impact significantly on the occupiers' budget (Dale, 1993). Thus to base the choice of design between different alternatives on the initial construction cost alone will be inadequate. Issues of maintenance and operation cost became important thus leading to the emergence of a costing technique that takes into cognisance of these aspects of cost.

WLC as defined by the BS ISO 15686 of service life planning (BSI, 2000) is a technique which enables comparative cost assessments to be made over a specific period of time, where all relevant economic factors both in terms of initial capital costs and future operational costs are considered.

Construction best practice programme (CBPP) defines WLC as:

'... The systematic consideration of all relevant costs and revenues associated with the acquisition and ownership of an asset"

The terminology has changed over the years from "cost in use" to "life cycle costing" and further to "whole life costing" (Flanagan & Jewell, 2005). Usually, the terms LCC and WLC are more common with little variance. The ISO Standard 15686-5 (ISO, 2008) brought out the difference between WLC and LCC. Their contention is that WLC is

equivalent to LCC plus external costs, thereby defining WLC as a broader term including life cycle costing and covering a wide range of analysis. Kirkham *et al.* (2002) also argued that the key difference between LCC and WLC is the notion that WLC is a management tool that is used throughout the building's life rather than the static option appraisal tool that LCC generally used for (Shittu, 2019).T0 prevent confusion, this research had chosen to use the term whole life costing (WLC).

Ashworth (2010) defined whole life cost as that which incorporates the total cost associated with a project from the inception through eventually demolition. They include the cost for construction, maintenance and demolition of the facility.

The Office of Government Commerce (OGC) Procurement Guide 07 year defines the whole-life costs of a facility as; 'the costs of acquiring it (including consultancy, design and construction costs and equipment), the costs of operating it and the costs of maintaining it over its whole life through to its disposal – that is, the total ownership costs.'

There are a number of definitions for whole life (or life cycle) costing, but the one currently adopted is: 'The systematic consideration of all relevant costs and revenues associated with the acquisition and ownership of an asset.' All the costs associated with various options for a project are added together to represent a total cost. Future costs are discounted tona present day value.

Essentially, whole life costing is a means of comparing options and their associated cost and income streams over a period of time. An alternative definition, from BS 3811 on maintenance management, stresses that it is 'for the purpose of making decisions.' Because the decisions involve considering events in the future as diverse as inflation rates, how long the building will be needed and what the weather will be like, there is a lot of

uncertainty in the results. However, it does provide a method of choosing between alyernatives on the basis of what we know and what we expect the future will bring.

The Encarta Dictionary (2019) defined practice as doing something in an established custom or habit, which has developed through experience. Hussein (2019) outlines the role each of the key players in the construction industry should play towards improving sustainability. For instance, the client should be asking the contractor for WLC information, considered how to reduce environmental impacts over the life of the building and could be keeping facilities management records to inform WLC on future projects. The design team requires the knowledge to provide environmental Information about the design and communicate with sub-contractors on the materials that are to be used. Materials suppliers need to be able to provide information on WLC, durability and maintenance data about their products. Bartlett & Howard (2000) support this by suggesting that construction professionals should know more about whole life costs to be able to inform their clients tobmake decisions based on sustainabilty aspects. They also highlight that manufacturers / materials suppliers have a huge influence on the supply chain in terms of being able to demolonstrate the whole life costs of their products to decision makers.

2.3 Uses of Whole Life Costing

WLC gives ‘reasoning for decision in conditions where there are elective methods for accomplishing a given article, and where those options vary in their underlying costs, yet in addition in their ensuing operational costs.'

It is especially used to:

a) Determine whether a higher initil cost is justified by reductions in future costs (for new build or when considering alternatives to ‘1ike’ or replacement).

b) Identify whether a proposed change is cost-effective against the 'do nothing' alternative, which typically has no initial investment cost, but higher future costs.

According to Ferry & Flanagan (1991), the utilization of WLC in any climate, exists on two levels. The lower level of life cycle costing is addressed as a 'The Management Tool' to help the dynamic interaction. The more significant level of life cycle costing is named 'The Management System' whose activity directs responsibility for asset management should be retained.

2.3.1 Whole Life Costing as a Decision-Making Tool

According to Kirk & Dell'Isola (1995) and Mackay (1999) as cited by Kishk *et al.* (2003), 80-90% of the running, maintaining and repairing cost of a building are determined at the design stage. Thus for an effective choice to be made between alternatives it has to be carried out during early design stages. In addition, the ability to influence cost decreases continually as the project progresses, from 100% at project sanction to typically 20% or less when construction begins HMSO (2002). Likewise, when the structure is conveyed, it is not probably going to have the option to make changes to the complete cost of proprietorship on the grounds that the choice to claim or to buy a structure regularly submits clients to the vast majority of the absolute expense of possession (HMSO, 2016). WLC examination techniques provide a platform for which comparisons can be made among competing choice of alternatives.

2.3.2 Whole life costing as a management tool

According to Kishk *et al.* (2003) opined that WLC can also be used as a management tool to identify the actual costs incurred in operating assets with the main objective of relating running costs and performance data. He further added that it could be useful for clients who want to estimate the actual running costs of the building and also for budgeting purposes as well as it becoming a valuable feedback device to assist in the design.

2.4 Principles of Whole Life Costing

Buildings by their nature have long design lives, therefore sustainability issues go beyond construction only. And hence other issues such as the operation, maintenance need to be incorporated into the design. According to Evans *et al.* (2019) the ratio between the cost of ownership, maintenance and building operation cost to that of business operating cost of a commercial building over a period of 25 years is 1: 5: 200 respectively. This means that for every one pound spent on construction cost, five are spent on maintenance and building operating costs and 200 on staffing and business operating costs. Although these ratios have been argued not to be supported by any empirical data by Hughes *et al*. (2004), they provided a ratio backed by an empirical study to be 1**:** 0.4**:**12. This means for every one pound spent on construction cost, 0.4 are spent on maintenance and building operating costs and 12 on staffing and business operating costs. The ratio shows the significance of maintenance and operating cost in the ownership of buildings.

Table 2.1: The Development Cycle

Stage	**Duration In Years**
Inception	1
Design	1
Construction	3
In-use	80

Source: Ashworth (2010)

2.4.1 An analysis of the cost structure

According to Bala *et al.* (2018) the Cost Breakdown structure addresses the manner in which whole life costs components are separated and introduced. The term building elements is traditionally used to refer to a classification scheme that is based on elements. Examples of elemental CBS are the Building Cost Information Service (BCIS) Standard Form of Cost Analysis for Building Projects Whyte *et al*. (1999), the cost classification scheme

used by BMI in its Price Information Book (BMI, 2019) and UNIFORMAT (Emmit & Gorse, 2003). An elemental CBS is usually hierarchical to enable costing at different levels of detail.

The intricacy and detail of the CBS relies upon the degree and targets of the WLC work out. The WLC ought to be introduced in a manner that empowers examination of choices. In WLC the structure parts are assembled into classes according to their usefulness.

2.4.2. Cost estimating

Having delivered a cost structure, it is important to work out the costs for every class; different strategies are accessible, one being the utilization of CERs (Cost Estimating Relationships). Cost estimating relationship (CER) is a numerical articulation which portrays, for predicative purposes, the expense of a thing or action as a component of at least one free factors (Fall, 1995).

2.4.3 Discounting

Discounting is a strategy used to change future costs or advantages over to introduce (where the buy choice is made) esteem utilizing an applied rebate rate and is the foundation of the time estimation of cash idea. Limiting is frequently mistaken for swelling yet they are independent ideas. The discount rate is hence not the expansion rate but rather it is the speculation premium well beyond the pace of swelling (Shittu, 2019). Discounting strategies incorporate the Net present Value (NPV), Equivalent Annual Cost (EAC), Discounted Payback Period (DPP), Net Savings (NS) and Savings to Investment Ratio (SIR).

2.4.3.1 Net Present Value (NPV)

Kishk *et al.* (2003) defined the NPV of an elective I, NPVi, as the amount of money that should be contributed today to meet all future monetary necessities as they emerge for the duration of the existence of the task. Clearly, the best other option, A*, is the one with least NPV.

2.4.3.2 Equivalent Annual Cost (EAC)

The EAC takes into contemplations of the cost of purchasing, working, and keeping a resource over its whole life (Will, 2020). Firms regularly use EAC for capital planning choices, as it permits looking at the cost adequacy of different resources with inconsistent life expectancy Rather than being communicated as a one-time net present worth, this strategy changes all cost of an option over to a uniform comparable yearly cost (EAC).

2.4.3.3 Discounted Payback Period (DPP)

The discounted pay period (DPP) is defined as the time, ordinarily in years, needed for the normal yearly reserve funds, taking into account the time estimation of money, to gather to restitution the contributed sum Kishk *et al*. (2003). The favoured other option, A*, ought to have the most limited restitution time frame. As indicated by Flanagan *et al. (*1987); Dale (1993), Kelly & Male (1993) as cited by Kishk *et al.* (2003) suggests that the DPP should just be utilized as a screening gadget before the use of all the more remarkable models. This is on the grounds that the technique disregards all incomes outside the compensation time frame (HMSO, 2002).

2.4.3.4 Internal Rate of Return (IRR)

Kishk *et al.* (2003) defined IRR as the rate procured on the measure of capital put resources into every time of the existence of the task subsequent to considering the reimbursement of the whole initially contributed. The positioning measure is that the

preferred option, A*, has the most extreme IRR. Numerically, the IRR for an elective I, is the loan fee r* that makes NPV = 0,

The calculation of IRR needs a trial and error procedure and more importantly, it assumes that an investment will generate an income which is not always the case in the construction industry.

2.4.3.5 Net Savings (NS)

The Net reserve funds strategy figures the net sum in PV terms that a venture choice is relied upon to save throughout the predefined time span (Kirkham *et al.*, 2002). The positioning standard is that the preferred option, A*, has the greatest NS. This technique, nonetheless, experiences the primary burden of the IRR strategy, for example it infers that a speculation will create a pay.

2.4.3.6 Savings to Investment Ratio (SIR)

As indicated by Kishk *et al.* (2003) the reserve funds to speculation proportion (SIR) is another customary Investment evaluation method. It is determined as the proportion of the current worth of the pay created by a speculation to the underlying venture cost. The higher the proportion, the more noteworthy the pound reserve funds per pound spent and thusly the proffered alternative option, A*, ought to have the most extreme SIR. Once more, this technique experiences a similar inconvenience of the NS strategy.

2.4.4 Inflation

The accentuation on inflation is to make a splitting line among it and discounting. Kirkham *et al.* (2002) believed that inflation must be viewed as where there is proof to recommend that expansion paces of components inside the model vary essentially.

2.5 Requirements of WLC

Al- hajj *et al*. (2001) identified the WLC requirements as follows:

2.5.1 Data Requirements

WLC data can be classified into the following categories;

Economic data - which consist of discount data and inflation rate and analysis period.

i. Cost Data- this includes the initial cost, maintenance cost, alteration cost, and the demolition or conversion cost.

ii. Times in the life cycle (time horizon).

iii. Performance Data.

Flanagan *et al.* (1989), Al-Hajj *et al.* (1991), Kirk & Dell'Isola (1995) identified the sources for WLC data to be

a) Historical Data

b) Specialist Manufacture's Data

c) Predictive Calculation

Historical Data

Historical data is information from existing structures as of now being used. A portion of this information might be gotten from customers as well as assessors' records. As indicated by Ashworth (2010) the support records are normally ready for bookkeeping reason and consequently for the most part impractical in this way to recover costs in the way needed for WLC.

Specialist Manufactures and Suppliers

According Flanagan *et al*. (2007), maker and additionally providers of specific materials or parts are relied upon to know the cost of their materials, and their life expectancy, upkeep and cleaning necessities. One trouble of such a data is that it very well may be of business nature, for example providers may in general support their items.

Predictive Calculations

Predictive modelling is a process used in predictive ana1ytics to create a statistical mode1 for future behaviour. Predictive analytics is the area of data mining concerned with forecasting probabi1ities and trends. Predictive models are to replicate running costs and those used in the construction industry can be broadly classified as detailed models, parametric models and estimating by analogy. In the detailed approach to cost estimating, costs are assigned to each element at the lowest level of detail. This method is time consuming and costly, it also requires a very detailed knowledge of all components and processes. In addition errors can be made in combining thousands of the detailed estimates into an overall estimate Ferry & Flanagan (1991). Notwithstanding above sources Ferry & Brandon (1991) featured six fundamental sources to WLC information: Technical press, Builder's price books, Information services such as the Building Cost Information Service (BCIS), Government research 1iterature such as from the National Economic Development Office (NEDO), University research and Technical information services.

2.5.2 The Analysis of uncertainty

The terms danger and vulnerability are frequently utilized reciprocally, although a qualification can be drawn by noticing that the idea of danger manages quantifiable probabilities while the idea of vulnerability does not. An occasion contains a component of danger where a likelihood appropriation can be defined (Dallas, 2006). An occasion is unsure when no probabilities can be created concerning its event. Danger alludes to probabilities of blunders in choices and WLC gauges for the duration of the life-pattern of a venture, or the probabilities of event of occasions (Flanagan & Norman, 2003). Risk appraisal manages the probability and assumption for conceivable WLC results utilizing likelihood ideas. Whenever registered as far as the likelihood of progress or inability to accomplish the profit from venture, the danger is viewed as a goal hazard. It is

vulnerability when the likelihood cannot numerically be shown however there is sufficient information to make an emotional judgment about the WLC choices. The more unequivocally the danger is characterized, the more prominent the opportunities for the chief to believe in utilizing the after effects of the WLC examination. Strategies in which vulnerability can be represented are Sensitivity Analysis, Probability Technique, Fuzzy set Theory and Integrated Approach (Ashworth, 2010).

2.5.3 The Cost breakdown Structure

According to Bakis *et al.* (2018) the Cost Breakdown structure addresses the manner in which whole life costs components are separated and introduced. The WLC ought to be introduced in a manner that empowers correlation of choices. In WLC the building components are assembled into classifications according to their functionality. Examples of CBS incorporate the Building Cost Information Service (BCIS) Standard Form of Cost Analysis for Building Projects Whyte *et al*. (1999), the cost arrangement plot utilized by BMI in its Price Information Book (BMI, 2019) and UNIFORMAT Kolo & Ibrahim (2010). An essential CBS is generally progressive to empower costing at various degrees of detail. The intricacy and detail of the CBS relies upon the degree and targets of the WLC work out.

2. 6 Whole Life Costing Tools

The SCI-Network: Working Group on Whole Life Costing classified WLC tools based upon their application.

2.6.1 WLC Frameworks

These are tools which provide principles and guidance to set a corporate approach to WLC. Within these frameworks one or a combination of different WLC tools can be applied. An example of a WLC Framework is ISO 15686-5:2018.

2.6.2 Total Building WLC

These are tools which allows for the calculation of the WLC of an overall building, including design, build and operate. An example of a Total Building tool is LC Profit.

2.6.3 Building Component WLC

These are apparatuses which are either not intended to, or adequately enough, to survey WLC of complete buildings or restorations, yet can give helpful monetary evaluations of various segment or framework choices, for instance the decision of warming or lighting framework. An illustration of this kind of hardware is WLC.

2.7 Whole Life Costing Calculation Methods

Davis (2007) classified WLC methods into the following

2.7.1 Deterministic method

This methodology utilizes a decision-making process that focus on customer satisfaction. It captures the needs of owner (customer) and translates it to a set of requirements that the proposed mutually exclusive options must meet to satisfy certain rules. Analyses of feasible alternative are made with regards to life cycle cost using the following steps:

a) Generate cost profiles.

b) Translate each profile to a proportionality measure to help a typical and valid premise of examination among thought about alternatives (by the utilization of time – estimation of cash elements to change over an anticipated stream of expenses to a solitary tantamount list.

c) Rank choices dependent on the result of the time estimation of money calculations. The least life cycle cost (estimated in yearly or present worth terms) choice is in this manner introduced as the suggested alternative.

d) Finally, the results of the procedure are passed on to the infrastructure owner to support rational decision making.

The deterministic approach uses historical data or professional judgment to determine fixed and discrete value for the input variable which is used to compute a single whole life cost estimate. A deterministic computation is straight forward and can be done manually using a calculator or automatically with a spreadsheet. However, it fails to convey the degree of uncertainty associated with the PV estimate. This method provides a logicl ordering of analytical activities and a credible means of ranking feasible options pertinent to the construction, refurbishment, and on-going management and support of infrastructure.

2.7.2 Sensitivity Analysis Technique

In general, sensitivity analysis involves the behaviour of model variables over predetermined bounds to determine their relative effect on model outcome. Through this process, analysts can:

a. Identify some subset of model variables that exert significant influence on model results
b. Determine break-even points that alter the ranking of considered options.

Sensitivity investigation, at that point, is an immediate affirmation that uncertainty regularly plagues even the most cautious and wise deterministic examinations. Following an underlying deterministic positioning of practical plan alternatives, affectability examination is utilized to build up the affectability of model outcomes (for example yearly

or present worth measures) and rankings across model factors of specific worry to examiners and leaders.

Notwithstanding the simplicity with which affectability examination might be utilized to infer significant bits of knowledge in regards to show results and orderly rankings, the self-assertive use of affectability investigation can demonstrate deluding. The data utilized in affectability investigations should be founded on some feeling of likely most extreme and least qualities.

2.7.3 Probabilistic comparison of options (risk analysis)

While sensitivity examination gives leaders some understanding with respect to the adaptability of model outcomes across a scope of variable gauges and comparing limits, it endures three significant inadequacies.

a. It may neglect to distinguish a predominant option among considered plan alternatives (this is positively the situation where annoyances in model factors upset the positioning of attainable plan choices).
b. Since affectability investigation normally includes the autonomous bother of each model variable, engineers and, thusly, clients do not acquire a feeling of the joined and synchronous impact of a few "irritated" model factors on the outcomes and rankings.
c. In the shortfall of characterized likelihood conveyances, the probability that specific qualities happen is let alone. The reason for hazard investigation is to address these weaknesses through probabilistic correlation of thought about alternatives.

In addition to the above three methods, Christensen *et al.* (2005) identified another WLC method, which is:

2.7.4 State-of –the- Art: An Iterative Approach to Life Costing

This strategy includes a systematic incorporation of input in the plan interaction through iterative correspondence among engineers and appropriate plan variables to allow an intermingling on a generally decent plan from client's viewpoint.

The iterative technique tends to vulnerability through express incorporation of affectability and danger investigations. It likewise recognizes and addresses the intricacy of the plan interaction through the consideration of input system consequently prompting a plan that best fulfils the client needs.

2.8 Implementation of Whole Life Costing in the Construction Industry

Kishk *et al.* (2003) citing Flanagan (1989) stated that in the implementation of WLC, three stages exist they are: WLC Analysis (WLCA) - the investigation comprises of gathering and breaking down notable information on the genuine costs of possessing practically identical buildings. This is intended to relate running costs and execution information just as give input to the plan group about the running costs of involved buildings.

i. WLC Management (WLCM) - this is the interaction of distinguishing proof of regions where cost can be decreased as demonstrated by the WLCA. The essential target is to evaluate and control costs all through the whole existence of the building to acquire the best incentive for the client.

ii. WLC planning (WLCP) - this comprises the forecast of all total cost of building, part of a building, or an individual building component. It additionally involves arranging the circumstance of work and consumption on the building with due thought concerning the impacts of execution and quality (Seeley 1996).

2.8.1 Stages of WLC Application in the construction Process

The following are the stages in which WLC can be applied.

i. At Inception: According to the framework of work in RIBA, at the beginning stage, the exercises did incorporate the recognizable proof of task objective (the customer's business case, manageability goals and different boundaries or imperatives) this will prompt the improvement of the underlying undertaking brief. Likewise at this stage site data is analyzed, achievability studies and evaluation of alternatives to empower the customer to conclude how to continue. Notwithstanding that the customer's danger profile is resolved and the venture program and primer acquirement system is resolved. Ashworth (2010) examined that at this stage WLC can be utilized in venture evaluation to help in settling on choice concerning proposed projects.

ii. At the design stage: At this stage, the readiness of idea configuration including diagram recommendations for underlying model, administrations frameworks, site scene, layout details and primer expense plan alongside ecological, energy, nature, access or other venture systems are viewed as prompting that concession to advancements to beginning undertaking brief and issue Final Project Brief. Besides the audit of obtainment procedure is completed, the plan duty including degree of execution determined plan making a move where required. The readiness of created configuration including co-ordinated and refreshed proposition for underlying model, administrations frameworks, site scene, layout particulars, cost plan and venture methodologies. Other perspective incorporates improvement of execution indicated work to take into consideration combination by expert subcontractors during finished plan stage. This is a phase where WLC idea is best because of the way that it very well may be utilized to assess distinctive plan alternatives to survey their financial effect for the duration of the existence of the undertaking. WLC idea is best at the reasonable and starter configuration

stage on the grounds that at these stages changes can be made without any problem. The plan with the least WLC is picked just as taking cognisance of other execution necessity.

iii. At Procurement: This stage is otherwise called the pre-development stage it manages the planning of creation data in adequate detail to empower a delicate or tenders to be gotten and examined just as an appropriate worker for hire to be picked. Additionally application for legal endorsements and the planning of additional data for development needed under the structure contract are totally conveyed at this stage. The WLC idea can be utilized at this stage by assessing the diverse strategy for acquisition and the best is picked dependent overall existence of the undertaking.

iv. At the Construction Stage: At the stage the agreement is let and a worker for hire is delegated thusly the organization of the structure agreement to Practical Completion. At this stage there are 3 expansive utilizations of WLC ideas ought to be thought of:

a) The contractor's technique for construction: the strategy for construction picked by the contractor particularly in civil – designing tasks influences the circumstance of income and thus the time estimation of such payments. Fabricate capacity parts of the undertaking can have impact on the cost being used thus the need to utilize construction strategies that are more productive and financial.

b) WLC way to deal with buy, rent or recruit of plants and types of gear: when assessment is made on these, the outcomes may affect future offering and assessing technique and project costs.

c) Input to the examination of plan: the development chiefs can give an expert contribution to the investigation of the plan, whenever included adequately from

the get-go in the venture's life. The might have the option to distinguish WLC ramifications of the plan with regards to fabricate and development and in the manner that task will be gathered nearby.

v. During the Project's Use and Occupation: WLC has a significant part to play in actual resource support the executives. The costs inferable from support do not stay uniform or static all through a task's life and thusly they should be checked on at regular stretches to evaluate their suggestions inside the administration of cost-being used.

2.8.2 Current WLC practice

Although most standards of WLC are all around created in principle, it has not gotten a wide viable application yet. A review attempted by BRE for DETR shows that life cycle costing is presently utilized broadly just in PFI project and public procurement (Clift & Bourke, 1999). Yet, Kirkham *et al.* (2002) states that inside the UK, WLC is considered in any business cases to legitimize capital interest in development and it apply to projects financed by customary public capital just as consequently the PFI and PPP procurement routes.

Studies have been led in the territories of WLC application in different nations, they incorporate that of Olubodun *et al.* (2010), Rum & Akasah (2011), Chirigwi *et al.* (2010), these works looked into the application of WLC in various countries highlighting the difficulties faced in implementation of WLC as well as the drivers to the application.

2.8.3 Barriers to WLC

The SCI organizing bunch believed that regardless of the unmistakable business advantages of WLC and the enormous number of instruments and direction archives

accessible, the use of WLC stays restricted in various Member States. In some application is restricted to enormous PPP projects and is generally attempted at the beginning phases of acquirement. The hindrances distinguished by the Networking bunch are Political, Data and Capability. Kishk *et al.* (2003) summed up territories of trouble in WLC practice in the following zones:

a. Industry barriers – The capital cost of construction is almost always separated from the running cost. It is normal practice to accept the cheapest initial cost and then hand over the building to others to maintain.
b. Client barriers
c. Analysis difficulties – this is due to the difficulty in obtaining the proper level of information upon which to base a WLC analysis.

Chirigwui *et al.* (2010) discovered that the absence of comprehension of WLC standards by the QS is a significant boundary to the execution of WLC. An examination in the UK by Olubodun *et al*. (2010) additionally discovered the absence of Understanding of the WLC standards is a significant obstruction to its execution, different hindrances incorporate shortfall of a normalized philosophy, intricacy of the interaction and saw mistakes. Ityobee (2016) detailed that reluctance of the Architects to give more than one plan and the obliviousness of most experts to WLC is significant hindrances to WLC application in the private area in the NCI. Another hindrance to WLC in the NCI is that arranged upkeep isn't completed (Iliyasu, 2004). And where there is upkeep (arranged or spontaneous), the expense records of such support are not kept (Bimba, 2008 & Waziri, 2009).

2.8.4 Drivers of WLC

The drivers to WLC are that the customer should needed by the customer, hands on way to deal with WLC preparing, arrangement of aides are key inspiring components to the act of WLC Chirigwui *et al*. (2010)

2.9 Roles of the Construction Team Members

While architect and some sections of engineering profession carry out the designs of building, the execution is the job of Builders, the project managers and the vital specialized supporting staff. In the light of the above mentioned, let us inspect the particular jobs and leads of building experts in executing building projects. Figure 2.1 shows a common place organogram for building project team members

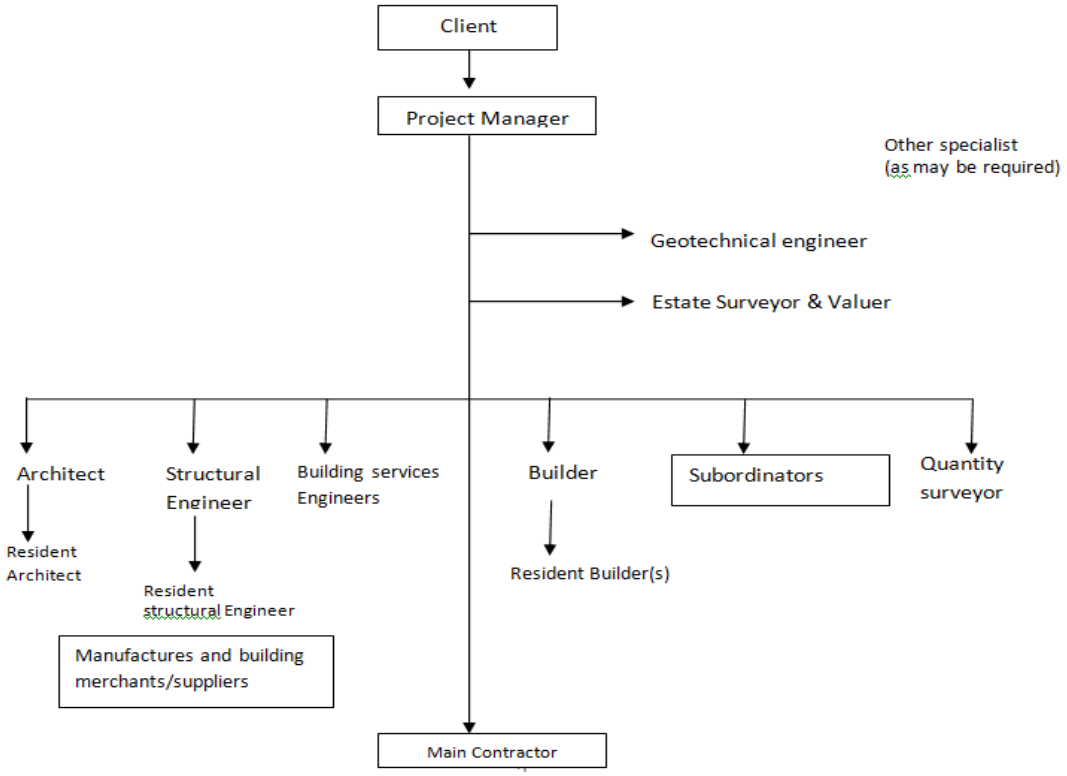

Figure 2.1: A typical organogram of team members on a public building project.

2.9.1 The Town Planer

Town planner is responsible for the orderliness in the developmental layout to show the various land use. Master plan, layout etc prepared by a Town planner normally take into consideration the population, culture, infrastructural facilities, socio economic, political, health and other human needs. During the execution stage, Town Planners will also ensure that the orderliness in the layout is not distorted and that the approval given is also adhered to strictly. For some building projects, there are needs for environmental impact assessment, which may be carried out by a town planner who has developed knowledge in this specialized area. This exercise must be carried out in collaboration with other relevant professionals. Town planners also carry out Site Analysis Report for building projects. (Anyanwu, 2015)

2.9.2 The Architect

The architect may assist the client with figuring his prerequisites in a reasonable structure, remembering any legal conditions that may apply. It will be worthwhile to the customer at this stage in the event that he could be shown work of similar nature so he could acquire a visual impression of shape, kind of materials, size and so on if this is beyond the realm of imagination, pictorial portrayals as well as model can be utilized, however it is regularly hard for the client to visual the genuine design from these creative portrayals. (Anyanwu, 2015)

According to Anyanwu (2015) the architect may need to help the client to bring together a team to give specific services such as that of a structural engineer, quantity surveyor, builder, mechanical and electrical engineers. Upon assessing cost limits and time scaled, conceptual design can be produced for client to approve or otherwise, before more detailed drawings are prepared. The cost of the building will have been broken down against elements at this stage with approximate values so that is if cost are to be adjusted it can be done within elements example: substructure, superstructure, internal finishes,

Mechanical and Electrical services. When general agreement has been reached between the client, and the consultants, the architect can now start detail design and preparation of contract drawings, schedules and specifications to enable tenders to be obtained. It is worthwhile to note that the situation whereby architectural drawings would have been completed before the structural and building services engineer's designs are commenced and inputs from a builder are obtained is not ideal and should not be encouraged by any member of the building project team. With the fulfilment of the tender documents, the architect and the other consultants will help the client in choosing the contractors to be welcome to tender for the building.

During the construction stage, the architect ought to visit site occasionally for investigations to ensure that, the work is being done nearby is incompliance with architectural design and specifications. Some projects may require the services of resident architect(s) on building project site.

2.9.3 The Engineers

Engineers are very important members of the design team whose responsibilities are to assist in the overall design of the project within the scope of their specialist fields. Engineers such as geotechnical, structural, electrical, mechanical, will carry out various analyses and calculations before arriving at the optimal design solution for a specific building. Thereafter, they will produce drawings, specifications, schedules and other relevant data that may be required for the overall design of the project and to assist the quantity surveyor in the preparation of bills of quantities and costing and the client in his assessment of the suitability of the project, regarding statutory requirements. During project execution stage, engineers visit the site periodically for inspections to ensure that in general, the work being carried out is in compliance with their engineering drawings, schedules and specifications. They are also available to modify or re-design their

individual aspects as may become necessary. Also some projects may require the services of resident engineers on the building project site. (Anyanwu, 2015)

2.9.4 The Quantity Surveyor:

A quantity surveyor ought to be called upon in the early phases of consultation by the client in light of his skill in construction costs. He ought to get ready above all else, a cost plan when the brief is settled, an approximate cost from sketch drawings, elemental cost checks during plan, so that, should the client's total be surpassed, the designer can consider every component of the building project in reasonable segregation, empowering him to pare costs as important, inside the total cost breaking point of the project. Upon acknowledgment by the client of cost and scheme, a quantity Surveyor's next task after the receipt of designer's drawings is to set up a Bill of Quantities (B.O.Q) in accordance with the current Standard Method of Measurement (SMM). This is a vital segment of the quantity surveyors duties and incredible consideration should be taken to ensure exactness. The bill of bill of quantities can only be great or precise as the drawings, schedules and specification details utilized for its planning.

During the preparation of the bills of quantities, the quantity surveyor has the chance to check measurements and advice on alternative materials. The quantity surveyor could likewise exhortation the client on the proper type of contact to use. The quantity surveyor will set up the contract documents in close meeting with different consultants on a project. At the point when tender document are conveyed to the contracts, the quantity surveyor should likewise price the BOQ and his estimated bill of quantities should be submitted and opened simultaneously as those of the tendering contractors. . When the tenders have been opened and recorded within the sight of different consultants, the tendering contactors and project manager client delegate, the quantity surveyor should check every one of the tenders for precision and consistency in evaluating and so on to accuracy that

the project workers made no genuine blunders, which could cause confusions sometime in the not too distant future. The quantity surveyor should then prepare a tender report on the Contractor Selection Meeting.

During the construction stage, the quantity surveyor will do carry out interim valuations, value variation, find out the measure of direct loss as well as cost brought about by the contactors, and agree fluctuations with the contractors, set up the proclamation of maintenance's and so on. All these ought to be done related to the contractors quantity surveyor who should to be permitted to be available at such critical points in time estimation are being completed on the site. In doing his obligations, the quantity surveyor should remain totally unbiased and without favour to one or the other side; this produces amicability in his job as a task cost chief. The amount assessor has a trustee obligation to learn that the customer gets an incentive for his cash and the worker for hire a satisfactory benefit for work done. On finish of the development stage, the amount assessor should help the undertaking chief in conversations with the project worker as to extra legally binding expenses. The quantity surveyor should likewise plan, with the guide of the contractor’s solicitations and other documents, the final account. (Anyanwu, 2015)

2.9.5 The Builder

A Builder is the professional at the centre of the physical construction of buildings. His role in building development process in general, is to construct the building. He does this by taking charge of the activities on a building construction site in translating designs, working drawings, schedules and specifications into a physical structure. He uses his production management expertise, coupled with the necessary resources such as money, manpower, materials, and machineries, in the site execution of building projects. His expertise in Building production management is the main professional input that he

renders on building projects. In constructing buildings, a Builder performs the following roles

a. Carry out Build ability and Maintainability analysis
b. Prepare Production Management Documents
c. Manage the production process on site.

The Builder's job in building improvement measure begins from the arranging/plan stage yet takes noticeable quality at the construction stage. The function of the Builder is the main thrust of this book. (Anyanwu, 2015)

2.9.6 The Estate Surveyor and Valuer

The Estate Surveyor and Valuer's roles in the planning of projects cannot be overemphasized. The features necessary to add economic and commercial values to any development are to be thoroughly analyzed by the estate surveyor and valuer. The input of the estate surveyor and valuer in the type of design or development that will suit a particular location is necessary to increase the sales or rentable value of a building after construction. There is no way one can say that the professional that will manage the estate after completion will not have meaningful input at the planning and execution of building projects. They should be involved at the early stage of building development process especially on commercial and speculative building projects, advising on current consumer trends, market demands and timing of entrance of the project into the market. The main task of the Estate Surveyor and Valuer on a building development project is to provide estimates for rental and capital value as well as to identify potential buyers and/or occupiers and to organize and implement the disposal of the development (3). At the very early stage, his initial valuation of the project is needed to assess the correct land price. Some important roles of the Estate Surveyor and Valuer on commercial building development are: (i) The identification of potential buyers or occupiers – The demand

market. (ii) The analysis of the requirements of occupiers and ensuring that they are incorporated into the design. (iii) The assessment of the rent or price that buyers or occupiers are willing and able to pay. (iv) The assessment of market conditions and possible changes that may arise during and after the development period. (v) The development and implementation of a marketing strategy. (vi) The monitoring of the effectiveness of the marketing strategy. (vii) The negotiations of lettings or sales (Anyanwu, 2015)

2.9.7 The Project Manager

While the duty regarding consenting to details is immovably positioned with the contractor, the implicit supposition that is made that except if a client keeps up his own delegate (the project manager) on the site to watch and investigate the works, the resultant design or building will not be in congruity with specified quality norm. While one may concur with the assertion, one will get a kick out of the chance to accept that it is in acknowledgment of this assertion of reality that all the standard type of building contracts consistently has a condition for the client to have an agent on location. The role of the client agent on site is to review nature of materials and the quality workmanship to ensure that they all consent to drawings and specifications. The individual equipped for reviewing materials and the workmanship of works should be an expert that is all around prepared in building construction, and with preparing in project the executives.

Notwithstanding, the size, type and intricacy of a specific structure undertaking may make it important to have in addition to the project manager, a residential builder, resident engineers and a resident architect. At the point when they are on the site addressing the interest of the client, their roles are integral. For instance, while the residential architect will investigate those materials, and parts indicated by the project architect and furthermore check measurements genuinely on site, the engineers will similarly assess

materials determined by every one of them (structural, electrical and mechanical) and their situating in progress, the residential builder will have to ensure by way of continuous examinations of the execution of construction methodology and the project manager will ensure that the project quality manager plan and phase of work is in congruity with the plan.

The contractor should usually cooperate with the project manager and treat him as the senior individual of the project team whose help and counsel as to exceptional project execution data, translation of creator's expectations, contract conditions, and so on, is impossible without. The project manager, as the client's representative should submit reports intermittently to the client. (Anyanwu, 2015).

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Design

Research design is action plan or a model upon which the entire study is built upon and it dictates the manner in which a study is conducted and provides the road map of a study in terms of the sample, data collection instruments and analysis procedure. Approaches on the other hand are paradigms, research framework, which may be either quantitative or qualitative or both (mixed approach) (Amos, 2017).

For the purpose of this research, a quantitative method with a data collection strategy that was based on survey and the questionnaire method were adopted in order to assess the use of WLC by members of design teams of building construction projects, taking into consideration the objectives of the research. The survey strategy explained the aim of the research and also assured respondents of the confidentiality of the information provided. The format of the questionnaire basically involved ticking and filling in blank spaces left for that purpose. This was adopted to facilitate easy response

3.2 Research Population

Research population refers to the group of entities to which the researcher intends to make an inference; such entities usually possess some unique common characteristics. A research population is known as well-defined collection of individuals or objects known to have similar characteristics. All individuals or objectives within a certain population usually have a common, binding characteristics or trait (Ibrahim, 2017). In view of the research questions highlighted in this study, the research population for the study was the professionals working in construction firms in Abuja, Federal Capital Territory. Such professionsls must have participated in the design and/or construction of at least one building project.

3.3 Sample Frame

The process of selecting a portion of population to represent the entire population is known as sampling Poliat, *et al.* (2017). Sample frame simply defined consists of the list of entities from which the specific entities to be sampled are selected. In other words the sampling frame represents the accessible section of the target population. According to Fellows Anita & Gunawan (2015) the objectives of sampling is to provide a practical of enabling the data collection and processing components of the research to be carried out and ensuring that the sample provides a good representationon of the population. For the purpose of this research, the sample frame was made up of the professionals working in construction firms in the study area, who could be accessed electronically and were willing to participate in an online survey. Although efforts were made to obtain the electronic contact addresses of as many of these professionals as possible through their professional associations, such efforts were not successful. The researcher was left with the only possible option of making direct electronic contact with likely sample elements based on personal knowledge of the subject of the study and the study area.

3.4 Sample Size

A sample size refers to the number of entities that are selected for the purpose of providing data in the survey (Zamboni, 2017). Under normal circumstances, sample size in research are determined by ensuring that it does not fall below the representative size obtained from statistical estimation theory which is based on the degree of confidence. Since this study utilised a purposive sampling approach, the number of respondent for this study could not be obtained from the sample size determination table of Krejcie & Morgan (1970), which assumed a confidence level of 95% and a margin of error of not more than 5%. Instead, for the purpose of this research, a purposive sample of the professionals in

construction firms who could be accessed electronically was carried out. A total of 63 professionals were eventually sampled.

3.5 Sampling Techniques

Sampling technique is a process or technique of choosing a sub-group from a population to participate in the study. It is also the process of selecting individuals for a study in such a way the individual selected represent the large group from which they were selected (Cheng, 2015). There are basically two kinds of sampling procedure, and they are: Probability and Non-proability sampling technique (Walliman, 2011). Probability sampling techniques present the most reliable representation for the whole population, because it gives each respondent an equal chance to be captured, while non-probability techniques rely on the judgement of the researcher, thereby making generalization on the population difficultlt and not justifiablele (Walliman, 2011).

In practice, two major sampling procedures are most commonly employed in research. These include purposive and simple random sampling. This was also done in this study. Purposive snowball sampling was used in selecting the construction firms' while simple random sampling was used in administering the questionnaires within each firm. The researcher believed the use of these approaches was justified in the light of the low diffusion of knowledge about WLC in the Nigerian construction industry.

3.6 Procedure for Data Collection

The research carried out reviews of existing literature first, so as to gain familiarity with the current status of research activity in the research area. Fellows Anita & Gunawan (2015) identified surveys, questionnaires, interviews, case studies and triangulation as a means of collecting data for the research works. For the purpose of this research, the tool for collection of data was a well-structured questionnaire. The questionnaire is an

instrument which is designed to collect data and address the objective of the research. Responses to the questions were presented using descriptive and inferential analysis.

3.7 Method of Data Analysis and Presentation

After collecting the information from the respondents via the structured questionnaire, the data gathered was carefully analyzed in relation to the stated objectives as presented in Table 3.1. The data for Objectives 1, 2 and 3 were analyzed using descriptive statistical method such as Relative Importance Index (RII) and Mean Item Score (MIS)). The analyzed data was presented using tables and charts.

Table 3.1: Methods of Data Analysis

S/N	Objectives	Data Tools	Analysis Instrument
1	i. Determine the extent to which Whole Life Costing has been practiced by design teams of building construction projects in Abuja, Nigeria;	Questionnaire	Descriptive statistics (Count , Percentages); MIS, RII
2	ii. Examine the factors influencing the use of Whole Life Costing by design teams of building construction projects;	Questionnaire	MIS, RII
3	iii. Examine the Barriers hindering the use of Whole Life Costing by design teams of building construction projects;	Questionnaire	MIS, RII
4	Make recommendations on how to encourage the increased use of Whole Life Costing by design teams of building construction projects.	Findings from analysis of data for Objectives 1, 2 and 3	-

Source: Author (2020)

White (2015) defined data as information obtained in a course of a study. Data analysis is a process of inspecting, cleaning transforming and modelling data with the goal of underlining essential information, suggesting conclusion and supporting decision making (Amos, 2017). It is the process which follows after data collection (Herath, 2017). For the purpose of this research, the collected data will analyzed using descriptive analysis and inferential analysis.

a) Objective One, which sought to examine to what extent whole life costing has been practiced among design team members' of building construction projects in

Abuja, Nigeria. To achieve this objective the quantitative data will be analyzed using descriptive statistics with Count. The quantitative data will also be analyzed using descriptive statistics with Percentages. The responses for each element would be studied to see how many components of WLC were considered by respondents for each element.

b) Objective Two dealt with the factors that drive the use of WLC. Relative Index of Importance and Mean Score will employed. Relative Index of Importance is a descriptive way of analyzing more than two variables. For the purpose of this study, the respondents will be asked to rate factor affecting whole life costing. The responses from the respondents would be obtained using a five (5) points Likert scale. The interpretation of the range of the Likert scale is as follows:

4.5 - 5.0	Strongly Agree,
3.3 - 4.49	Agree,
2.5 - 3.4	Average,
1.5 - 2.49	Disagree, and,
1.0 - 1.49	Strongly disagree.

c) Objective Three dealt with the factors that hinder the use of WLC. Relative Index of Importance and Mean Score will be employed. The responses from the respondents would be obtained using a five (5) points Likert scale as described previously.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Demographic Analysis of Respondents

The sample of respondents was drawn entirely from the professionals in the construction industry, as the demographic results presented in Table 4.1 revealed. The total of 63 professionals was made up of 10 architects (representing 15.87% of the sample); builders were 9 in number (14.29%); Engineers are eight in the sample (12.7%), while estate surveyors made up 9.52%, since there were only 6. Other professionals included in the sample were quantity surveyors, who comprised 28.57% of the sample, by far the largest single group. There were 3 town planners and 9 project managers as well (4.76% and 14.29% respectively). Based on the heterogeneity of the sample in terms of professional training of respondents, it can be reasonably expected that the results will be a fair representation of the situation in the Nigerian construction industry with respect to whole life costing.

In terms of educational accomplishments, 34.92% of the sample possessed either higher national diplomas or bachelor degrees in the relevant disciplines. The bulk of 63.49% of respondents had also obtained M.Sc. degrees. This level of training will enable the respondents understand the subject of the research and make useful contributions to the objectives of the study.

The participants in this study were drawn from consulting firms, contractors' organizations, government agencies, client organizations and the academia. Consulting firms and government agencies (MDAs) had the highest representation (26.98% and 23.81% respectively), followed by contractors' organizations and academic institutions, which had 19.05% and 17.46% respectively.

With respect to level of experience in the construction industry, nearly half of the sample (46.03%) had worked for between 5 and 15 years. A further 22.22% had worked for more than 15 years, in some cases up to 25 years. Respondents who had worked for less than 5 years comprised 26.98% of the sample. The respondents thus appear well placed to have had interaction with whole life costing (or the absence of it) during the period that they have worked in the construction industry.

Table 4.1: Selected demographics of respondents

Demographic parameter	Subgroups	Frequency	Percentage
Profession	Architect	10	15.87
	Builder	9	14.29
	Engineer	8	12.70
	Estate Surveyor	6	9.52
	Quantity Surveyor	18	28.57
	Town Planner	3	4.76
	Project Managers	9	14.29
Educational qualification	OND/NCE	1	1.59
	HND/B.Sc	22	34.92
	M.Sc	40	63.49
	Ph.D	0	0
Type of organisation	Consulting firms	17	26.98
	Contractor	12	19.05
	Client organization	6	9.52
	Ministries, Department, Agencies (MDAs)	15	23.81
	Academic institutions	11	17.46
	Others	2	3.18
Work experience	Less than 5 yrs	17	26.98
	5 yrs – 15 yrs	29	46.03
	16 yrs – 25 yrs	14	22.22
	More than 25 yrs	3	4.762

Four other aspects of the demographics of the respondents were presented in pie charts; these were the gender, type of project, type of client and type of procurement employed on projects that the respondents had participated in Fig. 4.1 it was apparent that the sample mirrored the gender situation in the construction industry; only 8% of the sample was female, leaving 92% males. The results of this study will thus be, on one hand, unavoidably skewed in favour of male views of whole life costing. On the other hand however, such results will be more likely a true representation of the gender situation in

the construction industry, as it has been proven by different researchers Jimoh *et al.* (2016).

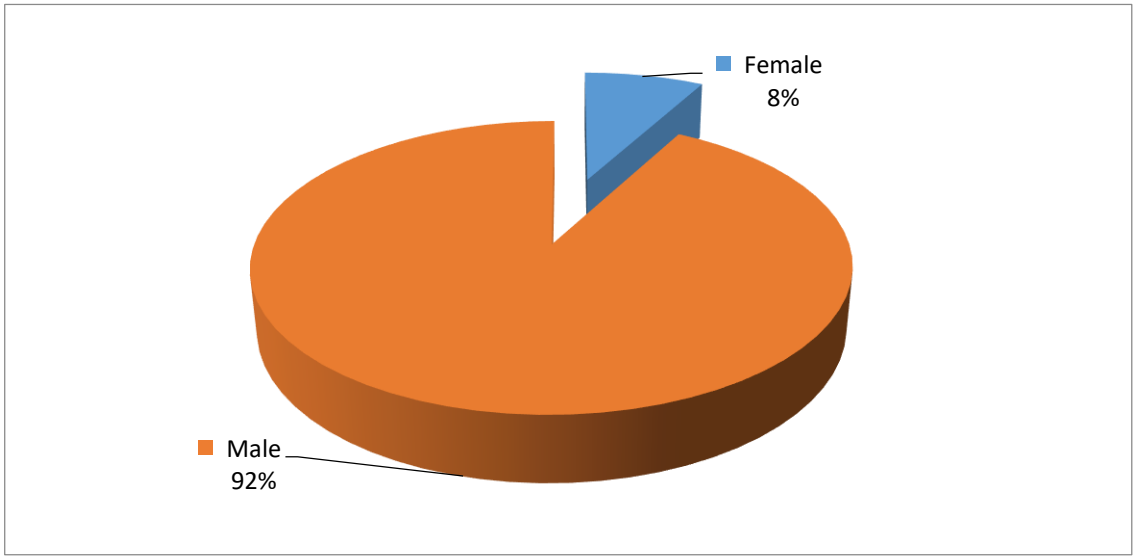

Fig. 4.1: Gender of respondents

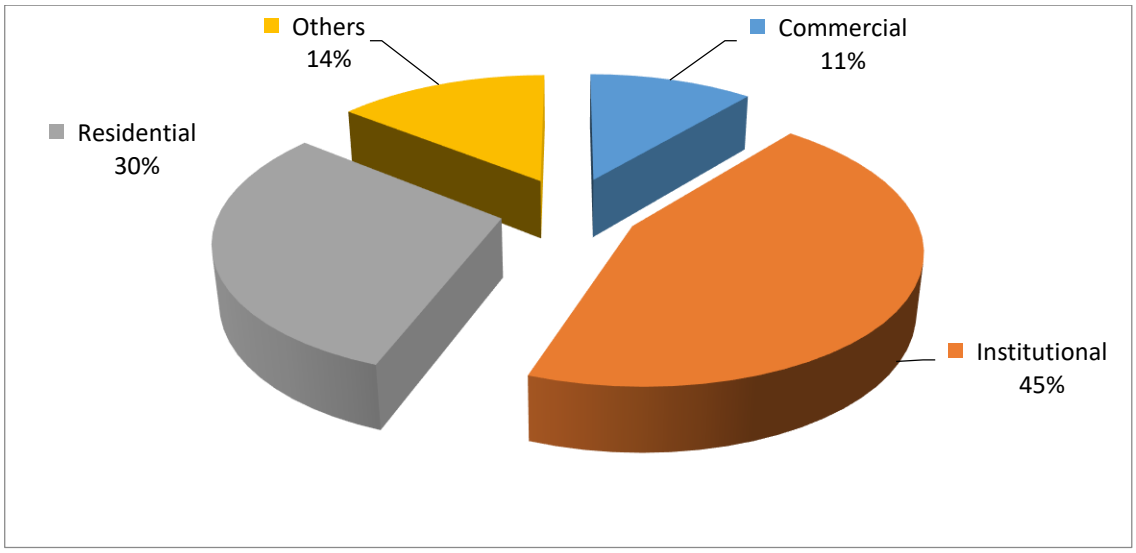

Fig. 4.2: Type of project

The respondents in this study worked on mainly three types of projects – institutional, residential and commercial as shown in figure 4.2, there were other projects types (probably mixed use types) which made up some 14% of the sample. Institutional projects were by far the most common group, making up 45% of the sample. This was followed by residential and commercial, which comprised 30% and 11% respectively.

Public sector clients were the most common client type within the sample; 57% of the sample belonged to this category. Private clients made up 13% of the sample, while Public-Private-Partnerships comprised 16% of the sample from fig 4.3.

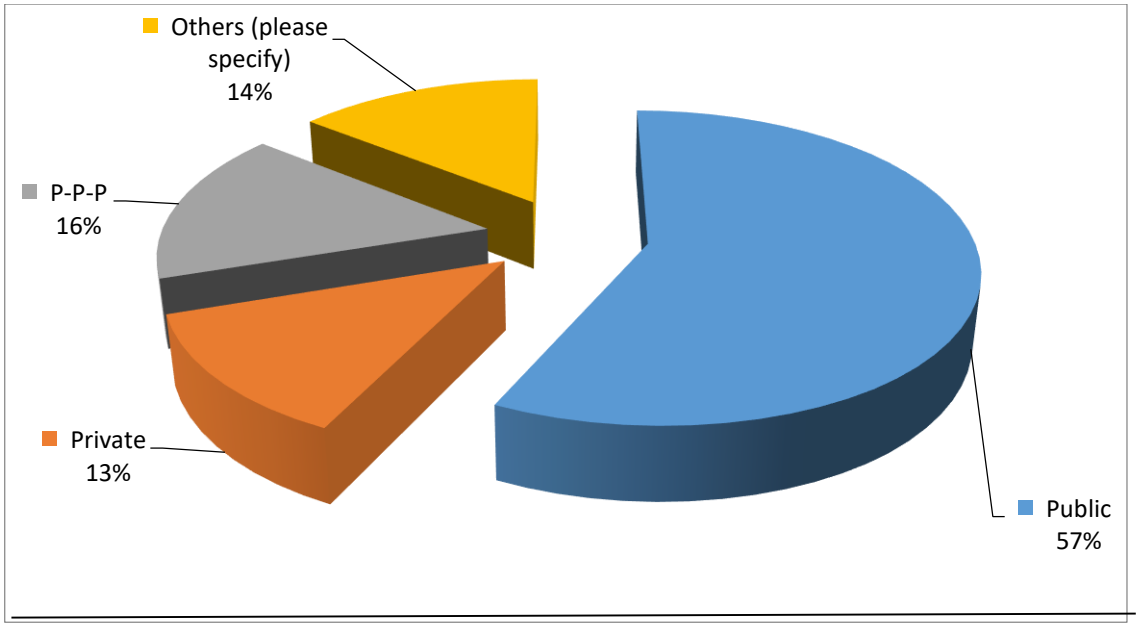

Fig. 4.3: Type of Client

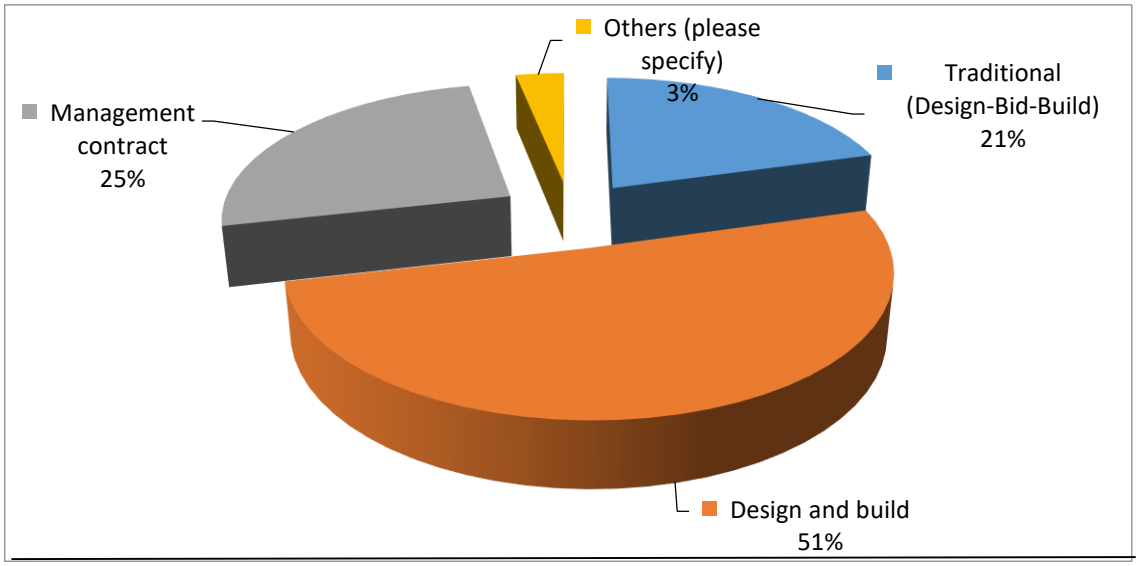

Fig. 4.4: Procurement type

The demographic results obtained from figure 4.4 also point to the ascendancy of design and build procurement systems in the Nigeria construction industry. This was as a result of the discovery that 51% of the projects handled by respondents were procured under 'design and build' systems. Traditional project procurement systems (often referred to as

'design-bid-build') made up only 21% of the sample. Management contracting, another more recent system of procurement, was employed in 25% of the projects under review.

4.2 Extent to which Whole Life Costing (WLC) is used by design teams

This section dealt with the identification of the different components of WLC which are employed by design teams as well as the frequency of their use. The 22 elements of buildings that are usually measured in Bills of Quantities (BoQ) were obtained from the Building and Engineering Standard Method of Measurement 4th Edition (BESMM4). Frequency analysis was employed in order to rank these elements in terms of the different components of WLC which are considered by design teams. The results are presented in Table 4.2. Respondents were requested to indicate what components of WLC they would consider for each of the 22 elements in the BESMM4. They could select all of the four components, or could decline by selecting the fifth option ('do not know'). The result is presented in Table 4.2. Two main discoveries were made from the results in Table 4.2. The first was that, although the research questionnaire explicitly provided for respondents to be able to select more than one WLC component per each element, yet all respondents selected just one component. This was evident from the totals of each column of WLC components in the table, which do not give a sum higher than the sample of respondents (which was 63). Was this a sign that the respondents did not understand the instructions, or was it a sign of poor understanding of WLC itself? There was no way of knowing from the data obtained during the field survey.

Table 4.2: Components of WLC employed by design teams

WLC ID	Building elements	Non Construction Cost	Construction Cost	Operation, Maintenance, Disposal Costs	Income from Project	Don't know
2.1	Piling;	22	27	4	0	10
2.2	In-situ concrete works;	8	44	9	0	2
2.3	Precast concrete;	2	32	25	1	3
2.4	Masonry;	12	22	18	7	4
2.5	Structural metalwork;	2	33	24	0	4
2.6	Carpentry;	7	31	14	8	3
2.7	Sheet roof covering;	16	34	10	1	2
2.8	Tile and slate roof and wall covering;	1	37	21	1	3
2.9	Windows, screens and lights;	10	40	5	4	4
2.1	Doors, shutters and hatches;	14	34	12	0	3
2.11	Stairs, walkways and balustrades;	15	39	5	0	4
2.12	Metalwork;	7	33	15	4	4
2.13	Glazing,	2	39	17	0	5
2.14	Floor, wall, ceiling and roof finishings;	10	35	16	0	2
2.15	Decoration;	0	43	9	5	6
2.16	Suspended ceilings;	0	38	22	0	3
2.17	Furniture, fittings and equipment;	9	30	21	0	3
2.18	Drainage above ground;	4	31	19	4	5
2.19	Drainage below ground;	4	29	19	6	5
2.2	Mechanical services;	8	23	27	0	4
2.21	Electrical services; and	2	33	21	2	4
2.22	Transportation (e.g. lifts)	20	19	12	8	4

The second discovery was that construction professionals appear to have a fixation on the construction cost of projects, often to the exclusion of other important costs. All construction projects have costs that are not directly related to the actual construction process. Such costs include land costs, statutory fees and levies, and fees for non-construction professional services (such as lawyers' fees, accountants/auditors' fees). The costs of running and maintaining a completed construction project has also been found to be many times higher than the cost of actual construction. Yet from the survey results, most construction professionals revealed that they always employed only the construction cost in evaluating the design of projects. These findings are clear evidence of the low level

of understanding and use of WLC in the study area, unlike what obtains in other climes. Kirkham *et al*., (2002) has stated that within the UK, WLC is always taken into account to justify capital investment in any construction business, whether financed by traditional public capital, PFI or PPP procurement routes.

4.2.1 Building elements most frequently associated with different components of Whole Life Costs

This subsection examined and ranked building elements in terms of the frequency with which they were associated with each of three different components of WLC. The three components were (i) non-construction cost, (ii) operation, maintenance and disposal cost, and (iii) income from project. The results were presented in table 4.2, 4.3, 4.4 and 4.5.

Non-construction costs are most commonly considered during the design of elements such as Piling, Lifts and Sheet roof covering. Non-construction costs have been described as those costs incurred in prosecution of the project but which are not directly associated with the actual construction process. According to Ferry & Flanagan (1991), whole life costing provides a rationale for choice where alternatives exist at different levels of cost; construction professionals in Nigeria however appear to be taking advantage of this rationale. In the case of piling, obtaining permits, conducting relevant tests, payments to non-construction professionals and so on might be reasonably expected to influence the design of the piling. The influence of non-construction costs on the design of lifts and sheet roof coverings does not appear to be as clear-cut.

Table 4.3: Building elements for which Non-Construction Costs are most frequently considered

Building elements	Non Construction Cost	Rank
Piling;	22	1
Transportation (e.g. lifts)	20	2
Sheet roof covering;	16	3
Stairs, walkways and balustrades;	15	4
Doors, shutters and hatches;	14	5

From the results in Table 4.3 it was observed that only about a third of the sample (the highest was 22 respondents in the case of piling) agreed that non-construction costs influence the design of the elements under consideration.

Mechanical services, precast concrete and structural metalwork are the three elements for which designers most frequently consider the costs of operation, maintenance and disposal (OMD) during the design phase. This position is quite understandable when services are considered; some types of services such as those employed in hospitals have running costs that are quite high compared to the initial installation costs. Consideration of OMD costs will also make the comparison of different alternative forms of concrete and structural metalwork more realistic. However, as in the case of OMD costs, only a maximum of 27 respondents (out of 63) agreed that OMD costs need to be considered for building elements.

Table 4.4 Building elements for which Operation, Maintenance and Disposal Costs are most frequently considered

Building elements	Operation, Maintenance, Disposal Costs	Rank
Mechanical services;	27	1
Precast concrete;	25	2
Structural metalwork;	24	3
Suspended ceilings;	22	4
Furniture, fittings and equipment;	21	5
Electrical services;	21	5
Tile and slate roof and wall covering;	21	5

Lifts, carpentry and masonry are three elements for which the income from projects is most frequently considered during the design phase. This finding was however based on a very small sample, since only 8 out of 63 respondents agreed with this position. The very small sample does not permit generalisation of the finding; at best, the finding can only be considered as exploratory in nature. It is also a vindication of the position of Olubodun *et al.* (2010) that lack of understanding of WLC principles is a major barrier to its implementation. Professionals in the Nigerian construction industry do not appear to

understand that the income generated from projects should form part of the rationale for choosing between alternative projects.

Table 4.5: Building elements for which Income from Project is most frequently considered

Building elements	Income from Project	Rank
Transportation (e.g. lifts)	8	1
Carpentry;	8	1
Masonry;	7	3
Drainage below ground;	6	4
Decoration;	5	5

4.2.2 Consensus agreement on use of different components of Whole Life Costing (WLC) by design teams

As part of the examination of the extent to which design teams employed WLC, the existence or otherwise of consensus opinions amongst the respondents with respect to the use of specific components of WLC is reported in this subsection. The Consensus Agreement approach employed a cut-off value of 70% as the minimum for a consensus opinion. A consensus agreement was used to describe the total number of respondents who 'strongly agree' or 'agree' with an opinion (Udoekanem, 2013). Wherever this proportion of responses relative to the total responses obtained reaches or exceeds 70%, it implies that the factor under consideration is the subject of a consensus agreement. Consensus agreements help to identify methods of use of WLC components that could be useful in the formulation of strategies for enhancing sustainable application of WLC in construction projects. The results for consensus agreement are presented in Table 4.6.

Table 4.6: Consensus opinion results for WLC components

Building elements	No. of respondents who selected				% proportion of sample that selected				**Remarks**
	NCC	**CC**	**OMDC**	**IFP**	**NCC**	**CC**	**OMDC**	**IFP**	
Piling;	22	27	4	0	34.9	42.9	6.3	0.0	No consensus
In-situ concrete works;	8	44	9	0	12.7	**69.8**	14.3	0.0	**Consensus only on CC**
Precast concrete;	2	32	25	1	3.2	50.8	39.7	1.6	No consensus
Masonry;	12	22	18	7	19.0	34.9	28.6	11.1	No consensus
Structural metalwork;	2	33	24	0	3.2	52.4	38.1	0.0	No consensus
Carpentry;	7	31	14	8	11.1	49.2	22.2	12.7	No consensus
Sheet roof covering;	16	34	10	1	25.4	54.0	15.9	1.6	No consensus
Tile and slate roof and wall covering;	1	37	21	1	1.6	58.7	33.3	1.6	No consensus
Windows, screens and lights;	10	40	5	4	15.9	63.5	7.9	6.3	No consensus
Doors, shutters and hatches;	14	34	12	0	22.2	54.0	19.0	0.0	No consensus
Stairs, walkways and balustrades;	15	39	5	0	23.8	61.9	7.9	0.0	No consensus
Metalwork;	7	33	15	4	11.1	52.4	23.8	6.3	No consensus
Glazing,	2	39	17	0	3.2	61.9	27.0	0.0	No consensus
Floor, wall, ceiling and roof finishings;	10	35	16	0	15.9	55.6	25.4	0.0	No consensus
Decoration;	0	43	9	5	0.0	68.3	14.3	7.9	No consensus
Suspended ceilings;	0	38	22	0	0.0	60.3	34.9	0.0	No consensus
Furniture, fittings and equipment;	9	30	21	0	14.3	47.6	33.3	0.0	No consensus
Drainage above ground;	4	31	19	4	6.3	49.2	30.2	6.3	No consensus
Drainage below ground;	4	29	19	6	6.3	46.0	30.2	9.5	No consensus
Mechanical services;	8	23	27	0	12.7	36.5	42.9	0.0	No consensus
Electrical services;	2	33	21	2	3.2	52.4	33.3	3.2	No consensus
Transportation (e.g. lifts)	20	19	12	8	31.7	30.2	19.0	12.7	No consensus

Legend: NCC=Non-construction cost; CC=Construction cost; OMDC=Operation, maintenance and disposal cost; IFP=Income from project

The closest to a consensus agreement that was observed was in the case of the use of 'construction cost' for '*insitu* concrete works'; this had a value of 69.8%, which to the nearest whole number would be approximated as 70%. This is an indication of the strength of the ingrained culture of the Nigerian construction industry that views project cost as synonymous with construction cost alone. This is in direct opposition to the definition of WLC by BSI (2010) as a technique which enables comparative cost assessments to be made over a specific period of time, where all relevant economic factors both in terms of initial capital costs and future operational costs are considered. *Insitu* concrete is an almost

ubiquitous structural material in the Nigerian construction industry; it is thus understandable that respondents agreed on this one element. The results in Table 4.6 further reinforce the perception that knowledge about and use of WLC is still at a low level in the part of the Nigerian construction industry that served as study area for this research.

4.3 Factors influencing the use of Whole Life Costing

This third section of the chapter dealt with the factors that drive the use of Whole Life Costing by design teams of building construction projects; this was the thrust of Objective Two of the study. The drivers of the use of Whole Life Costing by design teams were ranked using six (6) possible reasons presented as semantic statements. These statements were then presented to respondents to indicate the extent to which they agreed that design teams' use of Whole Life Costing was positively influenced by each individual statement. A 5 – hing semantic scale was utilized in the investigation survey to show level of arrangement ('5' for 'Emphatically Agree' (SA); '4' for 'Concur' (A); '3' for 'Neural' (N); '2' for 'Dissent' (D); '1' for 'Firmly Disagree' (SD)). A score of 3.50 or higher is in this manner needed to show an unequivocal degree of arrangement. Simple descriptive analysis tools, specifically Mean Score (MS) and Standard Deviation (SD) were employed to reveal the respondents' level of agreement with the statements about situations that drive design teams' use of Whole Life Costing. These results are presented in Table 4.7.

The 'Use of WLC required in order to successfully prove the viability of a project' was the highest ranked driver (MS = 4.34), while 'Because data for WLC was available and accessible to design team' (MS = 4.16) was ranked 2nd. Other top ranked drivers included 'Specific request from Clients' and 'Use of WLC required by the job (specific job requirements)' (MS = 3.87 and 3.87, ranked 3rd and 4th respectively). Chirigwui *et al.* (2010) has identified 'specific requirement by the client' as a key driver of WLC. It was

observed that respondents considered all of the six drivers to be important, hence the Mean Scores for the entire group lay between 3.50 and 4.49; this range corresponded to the 'Agree' portion of the semantic scale that was employed in the research questionnaire. The importance of training on and practical experience of WLC have been stated as key motivating factors to the practice of WLC by Chirigwui *et al*. (2010).

Table 4.7: Drivers of the use of Whole Life Costing by design teams

ID	Factors that influence your use of Whole Life Costing	Mean Score	SD	RII	Rank	Average Level of Agreement
3.3	Use of WLC required in order to successfully prove the viability of a project	4.34	0.81	0.85	1	Agree
3.4	Because data for WLC was available and accessible to design team	4.16	0.91	0.82	2	Agree
3.1	Specific request from Clients	3.87	1.08	0.76	3	Agree
3.2	Use of WLC required by the job (specific job requirements)	3.87	1.06	0.76	4	Agree
3.6	Based on past practice of design team in the case of similar projects undertaken	3.70	0.86	0.72	5	Agree
3.5	Because design team was knowledgeable about WLC and its advantages	3.70	0.59	0.72	6	Agree

Legend: SD=Standard deviation; RII=Relative importance index

4.4 Barriers hindering the use of Whole Life Costing

This fourth section of the chapter dealt with the factors that hinder the use of Whole Life Costing by design teams of building construction projects; this was the thrust of Objective Three of the study. The barriers of project design teams' use of Whole Life Costing were ranked using fourteen (14) possible reasons presented as semantic statements in the research questionnaire. These statements were then presented to respondents to indicate the extent to which they agreed that design teams' use of Whole Life Costing was negatively influenced by each individual statement.

A 5 – item semantic scale was employed in the study questionnaire to show level of agreement ('5' for 'Strongly Agree' (SA); '4' for 'Agree' (A); '3' for 'Neutral' (N); '2' for 'Disagree' (D); '1' for 'Strongly Disagree' (SD)). A score of 3.50 or higher is thus

required to indicate an unconditional level of agreement. Simple descriptive analysis tools, specifically Mean Score (MS) and Standard Deviation (SD) were employed to reveal the respondents' level of agreement with the statements about situations that hinder project design teams' use of Whole Life Costing. These results are presented in Table 4.8. The five top-ranked barriers included 'Government policy and regulations such as absence of standards for WLC' which was the highest ranked barrier (MS = 4.34); 'Existing non-mandatory use of WLC for public projects especially' (MS = 4.24) was ranked 2nd while 'Unrecognised business benefits of WLC' (MS = 4.03) was ranked 3rd. The 4th ranked barrier was 'Insufficient end user training for construction professionals and policy makers' (MS = 4.00). In 5th place was 'The existing government – approved Scale of Professional Fees is based on construction costs only' (MS = 3.87). These findings coincided with those of Olubodun *et al.* (2010) in the UK that lack of understanding of WLC principles, absence of a standardised methodology, and complexity of the process are barriers to the implementation of WLC.

Table 4.8: Barriers of the use of Whole Life Costing by design teams

ID	Factors that negatively influence your use of Whole Life Costing	Mean Score	SD	RII	Rank	Average Level of Agreement
4.05	Government policy and regulations such as absence of standards for WLC	4.34	0.81	0.85	1	Agree
4.04	Existing non-mandatory use of WLC for public projects especially	4.24	0.76	0.83	2	Agree
4.03	Unrecognised business benefits of WLC	4.03	0.99	0.79	3	Agree

4.06	Insufficient end user training for construction professionals and policy makers	4.00	0.61	0.76	4	Agree
4.14	The existing government – approved Scale of Professional Fees is based on construction costs only.	3.87	1.26	0.76	5	Agree
4.10	Decision makers may opt for minimum initial investment either to increase return on investment or meet budgetary restrictions	3.85	1.10	0.76	6	Agree
4.01	Acceptance of WLC system by the Nigerian Construction Industry	3.84	1.05	0.70	7	Agree
4.02	Inflexible company and societal culture of not planning into the distant future	3.82	0.93	0.75	8	Agree
4.13	Complexity of WLC process	3.82	0.91	0.75	9	Agree
4.12	The difficulties involved in forecasting multiple factors such as future operating and maintenance costs, and discount and inflation rates, over a long period of time.	3.76	0.95	0.74	10	Agree
4.09	The lifespan of political institutions such as governments (maximum of 8 years) is much shorter than that of buildings (usually taken as 60 years), hence non-consideration of WLC.	3.31	0.93	0.65	11	Neutral
4.08	Politically, capital budgets for construction are separated from the operating / maintenance budgets for the same facility / project	3.28	1.29	0.63	12	Neutral
4.11	Availability and quality of data upon which to base WLC calculations	3.15	0.63	0.60	13	Neutral
4.07	Lack of technical expertise and capacity	2.71	0.98	0.53	14	Neutral

Legend: SD=Standard deviation; RII=Relative importance index

Based on the Mean Scores (MS) obtained, respondents agreed that ten of the 14 statements/circumstances listed could serve as barriers to the use of Whole Life Costing by design teams of building construction projects. This was because all of the 10 statements/circumstances had MS which were higher than 3.50. On the other hand, respondents were neutral about four statements; this was because the Mean Scores of these statements were less than 3.50. These statements had to do with issues such as 'lifespan of buildings being much longer than that of political administrations', 'separation of capital budgets from the operating/maintenance budgets' and 'availability and quality of WLC data'. This last barrier has also been identified by Bimba (2008) & Waziri (2009), when they opined that cost records of maintenance activities are not kept.

4.5 Discussion of Findings

The main findings of this study can be summarised as follows:

1. Construction professionals in the Nigerian construction industry, specifically within Abuja, which is the study area, tend to consider only the construction cost of projects as representative of project costs, often to the exclusion of other important types of costs. The results presented by this study further reinforce the perception that knowledge about and use of WLC is still at a low level in the Nigerian construction industry.

2. Some of the key factors that drive the use of WLC in the Nigerian construction industry are (i) availability of data for WLC and (ii) clients specifically requesting the use of WLC.

3. Some of the key barriers that hinder the use of WLC in the Nigerian construction industry are (i) absence of standards for WLC; (ii) non-mandatory use of WLC for public projects; (iii) non-awareness of the business benefits of WLC; and (iv) insufficient end user training for construction professionals and policy makers.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study aimed to enhance the value for money spent on housing through an evaluation of the practice of Whole Life Costing (WLC) by members of design teams of residential housing projects. To this end, three objectives were pursued to determine the extent of practice of WLC and examine both the drivers and barriers of the use of WLC. The study has found that construction professionals in the Nigerian construction industry (NCI), specifically within Abuja, which is the study area, tend to consider only the construction cost of projects as representative of project costs. This means that other important types of costs are often excluded when alternative projects, facilities or means of construction are being considered.

This study has concluded that the perception that knowledge about and use of WLC is still at a low level in the Nigerian construction industry is attributable to low availability of data for WLC and very few instances of clients specifically requesting the use of WLC. These two factors, among others, if properly encouraged can serve as drivers of the use of WLC in the Nigerian construction industry.

5.2 Recommendation

This section presents the recommendations which this study has proposed, with respect to the aim and objectives of the study as outlined earlier.

1. There is an urgent need to upskill construction professionals in the area of WLC practice. Current cost practice in the Nigeria construction industry coupled with training curricula that have traditionally focussed on only construction costs make it imperative that existing and future professionals in the NCI should be re-oriented as to the pivotal importance of WLC. It is suggested that this can be achieved in the following ways:

a) Redesign of tertiary education curricula (as it concerns construction disciplines) to focus on WLC rather than construction or installation costs alone. This can be handled by statutory bodies such as the QSRBN, COREN, and CORBON.

b) Series of continuing professional development (CPD) seminars and workshops that will help to upskill existing construction professionals in the area of costing of construction works. Trade associations such as the NIQS should spearhead this effort.

c) A joint effort of the Bureau of Public Procurement (BPP), trade associations such as the NIQS and statutory bodies such as the QSRBN, COREN, and CORBON should be mounted to educate and inform the National Assembly and State Houses of Assembly on the need to amend existing construction industry laws that currently ignore WLC. This will ensure that all levels of government, which collectively are the largest clients of the construction industry, are aware of and make effort to adopt the use of WLC for their projects.

2. The second recommendation of the study has to do with ensuring availability of relevant data for the use of WLC. At present some of these data are impossible to obtain. There is thus need for an aggressive and sustained effort to harness cost data on design, construction, and especially operation and maintenance of construction projects. This can be handled by the BPP.

3. The third recommendation of the study is on removing the key barriers that hinder the use of WLC in the Nigerian construction industry. To this end, stakeholders (both professional and statutory) in the construction industry need to work towards (i) provision of standards for WLC; and (ii) making the use of WLC mandatory for public projects.

5.3 Contribution of Study to Knowledge

This study has contributed to knowledge primarily by showing the very low level of WLC practice in the NCI. Construction professionals have been shown to consider project costs as synonymous with only construction costs. This renders decision making about costs valid and limited to only the present time, effectively ignoring the much longer period of time during which the project will be in use. All stakeholders within the construction industry are concerned with WLC; this is why entrenching the use of WLC has to be an industry-wide effort. One of the contributions of this study is the identification of factors that can serve as barriers to the use of WLC, so that efforts can be made to eliminate such factors.

5.4 Areas for Further Studies

This study has evaluated the practice of WLC by design teams of building construction projects. it is probably that WLC practice might vary during construction of projects, from tenderer to tenderer, or by type of project, whether residential, commercial, institutional and so on. The study thus suggests the following areas for further studies.

1. Evaluation of the practice of WLC by construction teams of building construction projects;
2. Evaluation of the effect of type of project on the practice of WLC in building construction projects
3. Evaluation of the practice of WLC in design-build-operate PPP projects.

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APPENDICES

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA
SCHOOL OF ENVIRONMENTAL TECHNOLOGY,
DEPARTMENT OF QUANTITY SURVEYING
MAIN CAMPUS GIDAN-KWANO. MINNA. NIGER STATE.

Department of Quantity Surveying,
School of Environmental Technology,
Federal University of Technology,
P.M.B. 65, Minna, Niger State.

21st February, 2020

Dear Participant,

Re: Whole Life costing practices employed by design teams of building construction projects in Abuja, Nigeria

My name is **NALAYA, Emily Nkoro** a Masters (M.Tech) Degree student of Quantity Surveying**,** Department of Quantity Surveying, School of Environmental Technology, Federal University of Technology Minna, Niger State. I am conducting research on ***''Whole Life Costing practices employed by design teams of building construction projects in Abuja, Nigeria''.***

Your participation in filling the attached questionnaire will be crucial to the successful conclusion of this research. Please note that all information provided will be used for academic purposes only, and no personal identity information is required. Therefore do not include your name or telephone number in your response.

If you have questions or observations at any time about the survey or procedures, please make use of the contact information below:

Thank you very much for your support.

Name:	**NALAYA, Emily Nkoro**	Dr. A. A. OKE
Position:	Researcher	Supervisor
Contact information:	MTECH/SET/2018/9172	08023737241; abdganioke@futminna.edu.ng

Research Survey

Whole Life Costing practices employed by design teams of building construction projects in Abuja, Nigeria

By
NALAYA, Emily Nkoro
Department of Quantity Surveying, Federal University of Technology Minna, P.M B. 65, Minna, (Gidan Kwano Campus), Niger State, Nigeria.

Section A: Demographic information

Q1. Please provide information about the respondent as requested by selecting one of the options provided.

A	Profession of respondent	1	Architect	
		2	Builder	
		3	Engineer	
		4	Estate Surveyor	
		5	Quantity Surveyor	
		6	Town Planner	
		7	Other (specify)	

B	Educational attainments	1	OND/NCE	
		2	HND/B.Sc	
		3	M.Sc	
		4	Ph.D	

C	Type of organisation	1	Consulting firms	
		2	Contractor	
		3	Client organization	
		4	Ministries, Department, Agencies (MDAs)	
		5	Academic institutions	
		6	Others	

D	Work experience of respondent	1	Less than 5 yrs	
		2	5 yrs – 15 yrs	
		3	16 yrs – 25 yrs	
		4	More than 25 yrs	

E	Respondents gender	1	Female	
		2	Male	

F	Type of project	1	Commercial	
		2	Institutional	

	3	Residential	
	4	Others	

G	Type of Client	1	Public	
		2	Private	
		3	P-P-P	
		4	Others (please specify)	

H	Procurement type	1	Traditional (Design-Bid-Build)	
		2	Design and build	
		3	Management contract	
		4	Others (please specify)	

I	Size of project (gross floor area in square metres)		**M^2**

J	Number of floors in project		

K	Initial contract sum (in Naira)		

L	Initial completion period (In Weeks)		

Section B: Ways in which Whole life Costing (WLC) is used by design teams

Q2. Kindly indicate which of the WLC components that you always consider during design, by ticking **as many** of the five options provided as may apply to you

	Which of the listed components of Whole life Cost (WLC) ***do you calculate during design*** of the following work items:	**1** **Non Construction Cost**	**2** **Construction Cost**	**3** **Operation, Maintenance, Disposal Costs**	**4** **Income from Project**	**Don't know**
2.1	Piling;					
2.2	In-situ concrete works;					
2.3	Precast concrete;					
2.4	Masonry;					
2.5	Structural metalwork;					
2.6	Carpentry;					
2.7	Sheet roof covering;					
2.8	Tile and slate roof and wall covering;					

	Which of the listed components of Whole life Cost (WLC) ***do you calculate during design*** of the following work items**:**	1 **Non Construction Cost**	2 **Construction Cost**	3 **Operation, Maintenance, Disposal Costs**	4 **Income from Project**	**Don't know**
2.9	Windows, screens and lights;					
2.10	Doors, shutters and hatches;					
2.11	Stairs, walkways and balustrades;					
2.12	Metalwork;					
2.13	Glazing,					
2.14	Floor, wall, ceiling and roof finishings;					
2.15	Decoration;					
2.16	Suspended ceilings;					
2.17	Furniture, fittings and equipment;					
2.18	Drainage above ground;					
2.19	Drainage below ground;					
2.20	Mechanical services;					
2.21	Electrical services; and					
2.22	Transportation (e.g. lifts)					
2.23						
2.24						
2.25						

Section C: Factors influencing the use of Whole Life Costing

Q3 Kindly use the five point scale provided to rate the extent to which you believe each of the following factors influences your use of Whole Life Costing:

WLC driver ratings:

5 (SA) = Strongly Agree; 4 (A) = Agree; 3 (N) = Neutral; 2 (D) = Disagree; 1 (SD) = Strongly Disagree.

	Factors that influence your use of Whole Life Costing	5 SA	4 A	3 N	2 D	1 SD
3.1	Specific request from Clients					
3.2	Use of WLC required by the job (specific job requirements)					
3.3	Use of WLC required in order to successfully prove the viability of a project					
3.4	Because data for WLC was available and accessible to design team					
3.5	Because design team was knowledgeable about WLC and its advantages					
3.6	Based on past practice of design team in the case of similar projects undertaken					
3.7						
3.8						

	Other factors that influence your use of Whole Life Costing (please specify)					
3.9						
3.10						
3.11						

Section D: Barriers hindering the use of Whole Life Costing

Q4. Kindly use the five point scale provided to rate the extent to which you believe each of the following factors hinders your use of Whole Life Costing:

WLC barrier ratings:

5 (SA) = Strongly Agree; 4 (A) = Agree; 3 (N) = Neutral; 2 (D) = Disagree; 1 (SD) = Strongly Disagree.

	Barriers hindering the use of Whole Life Costing	5 SA	4 A	3 N	2 D	1 SD
4.1	Acceptance of WLC system by the Nigerian Construction Industry					
4.2	Inflexible company and societal culture of not planning into the distant future					
4.3	Unrecognised business benefits of WLC					
4.4	Existing non-mandatory use of WLC for public projects especially					
4.5	Government policy and regulations such as absence of standards for WLC					

	Barriers hindering the use of Whole Life Costing	5 SA	4 A	3 N	2 D	1 SD
4.6	Insufficient end user training for construction professionals and policy makers					
4.7	Lack of technical expertise and capacity					
4.8	Politically, capital budgets for construction are separated from the operating / maintenance budgets for the same facility / project					
4.9	The lifespan of political institutions such as governments (maximum of 8 years) is much shorter than that of buildings (usually taken as 60 years), hence non-consideration of WLC.					
4.10	Decision makers may opt for minimum initial investment either to increase return on investment or meet budgetary restrictions					
4.11	Availability and quality of data upon which to base WLC calculations					
4.12	The difficulties involved in forecasting multiple factors such as future operating and maintenance costs, and discount and inflation rates, over a long period of time.					
4.13	Complexity of WLC process					
4.14	The existing government – approved Scale of Professional Fees is based on construction costs only.					
4.15						
4.16						
4.17						

Other barriers hindering the use of Whole Life Costing (please specify)

4.18						
4.19						
4.20						

Thank you!