Procurement process for sustainable development: The Role of Life Cycle Costing (LCC) Integration

Mohammed Lawal Yahaya[1], Abdullahi Muhammad[2], Sabo Lawal Abubakar[3], and Zainab Ango Murtala[4]

[1]Department of Physical Planning and Development, Usmanu Danfodiyo University, Sokoto Nigeria, *mohammedlawalyahaya@gmail.com.com*
[2]Department of Quantity Surveying, Ahmadu Bello University Zaria, Kaduna State, Nigeria bnabdallah.02@gmail.com
[3]Department of Quantity Surveying, Jardin Nigeria Limited, Abuja Nigeria qssabo@gmail.com
[4]Works and Services Department, Federal Neuro-psychiatric Hospital Kware Sokoto, Sokoto State, Nigeria *nabuango@yahoo.com*.

DOI: https://doi.org/10.5281/zenodo.15106839

Abstract

The current public procurement policies in Nigeria aimed at achieving value for money, negating delivering in terms of broader policy objectives that entails sustainability pillars. The research aims to improve tender evaluation process by integrating a multi-criteria decision making approach using the life cycle costing (LCC) tool, moving beyond the traditional priced-focused method. A case study approach for the procurement and award process of school procurement was undertaken. The overall results indicated that the award criterion with LCC integration has yielded the most advantageous tender among the three student buses of 32.33%, 33.83% and 33.84% cost variances which considered sustainability benefits in each item. Furthermore, the results indicated that the institution was able to relieve itself with the challenges of wrong selection of tender with short term run economy. In conclusion, the research inform the Bureau of public procurement and procurement officer in public organizations to promote the application of LCC when analyzing and evaluating bids in the award of developmental projects for economic, environmental and social benefits.

Keywords: Bids evaluation, Life Cycle Costing, Net Present Value (NPV), Public Procurement Act 2007, Sustainable development, Tertiary Institutions

1. INTRODUCTION

Tender evaluation for the award of contract in public procurement entails a multifaceted process which requires understanding and deep knowledge of legal framework for ensuring the successful delivery of public projects. In Nigeria today, the Public Procurement Act 2007 is the legal framework for the delivery of public projects in all federal organizations, setting guidelines for transparency and accountability. The Act Part IV S.16, Part VI S.24, 25, 29, 31, 32 and 33 has detailed the process of bids evaluations for the open competitive tendering as a default method. Organizations are being confined always to follow this guidelines in any of their bids evaluation process, even thus seems to be feasible and beneficial in making the process to be transparent and more economic when compared with other methods.

However, as more complex projects are being conceptualized in many organizations with it peculiar challenges or difficulties which needs advance methods of evaluation. These seem to render the traditional bids evaluation process less effective and in-appropriates in such conditions. In addition, multiple studies highlight persistent challenges within the traditional bids evaluation process, particularly issues related to inefficiencies, corruption and lack of transparency (Williams-Elegbe, 2015, Yahaya, Oyediran & Onukwube, 2019). To buttress these issues Ajaelu, Samuel and Isiofia, (2021) assessed tender processes at the tertiary institutions level, revealing various weaknesses that compromise public project delivery. These findings emphasize the necessity for adherence to global standards defined by objectivity and reliability. Similarly, Suleiman, Saidu, Adamu and Tsado, (2024) investigated bid evaluation risk management in Nigerian tertiary institutions, risks in the form of information leakages that undermine the project objectives are always being exposed in such bids evaluation method. Further, critical review and observations across several studies has also attributed the non-adoption of technology based evaluation method to replace the traditional method of manual, paper-based bids evaluation (Abdullahi, Ibrahim, Ibrahim & Bala, 2019; Oyediran & Akintola, 2011). By adopting such approach, potential enhancements in transparency and fairness could be achieved.

Therefore, integrating global lessons into the Nigerian procurement framework is a recurring theme. For instance, the Nigerian Economic Summit Group (NESG, 2017) provides comprehensive insights between Nigerian and best practices in the global, suggesting the adoption of international best practices in all the procurement processes in Nigeria. Furthermore, Ekung, Lashinde and Amuda, (2015), propose procedural improvements that align Nigerian practices with global benchmarks to enhance procurement efficacy.

Contemporary studies in the public procurement have indicated the needs for shift from the traditional method of contractor selection (Naiyehu, Ogedengbe & Aderoba, 2013; Ozyurek & Erdal, 2018; Olander & Norinder, 2024). Global trends in the adoption of traditional method (price-based) selection show that about 50-65% of the European Union (EU) countries adopt this method in their selection of contractors (Ozyurek & Erdal, 2018; Plebankiewicz, 2024).The price-based method for bid evaluation has been criticized of non-standardization, corruption, time overrun, difficulty in decision making and vulnerable to risk in the selection processes. Price-based method has been contributed towards numerous issues such as (i) inefficiencies in the awarding of contract, (ii) prevention of competent contractor selection, (iii) poor quality delivery, (iii) budget overruns, and project failures, (iv) predominant focuses on price only for an award (Naiyehu, Ogedengbe & Aderoba, 2013; Ozyurek & Erdal, 2018;Plebankiewicz & Kozik, 2017).

Current public procurement policies used in Nigeria primarily focuses on price-based issues while neglecting other critical factors that assess a contractor's overall capability such as environmental, maintenance and operation costs etc. This leads to issues of poor quality delivery, budget overruns, favoritism, corruption and high demand for selective tendering in many organizations. Furthermore, existing studies and practices often neglect a comprehensive multi-criteria decision making approach in contractor selection, focusing mainly on project constraint, risk and procurement methods selections. There has been limited focus on bid evaluation criteria improvements in contractors' selection for construction projects in Nigeria.

Therefore, considering other forms of evaluation criteria such as Life Cycle Costing (LCC) as non-price based method by the procurement entities will overcome some of these challenges, allowing other factors to determine the best contractors among the bidders. These will increase quality, value for money, less delivery time and performance of contractor (Naiyehu, Ogedengbe & Aderoba, 2013; Ozyurek & Erdal, 2018, 2023). In addition, these gaps highlight the necessity for further research and practical need for the integrating LCC tool into the financial bids evaluation process in the award of contract while adhering to public procurement principle and with a view to enhance the objectivity and effectiveness of our procurement processes in general.

Therefore, the study aim to improve tender evaluation process by integrating a multi-criteria decision making approach using the life cycle costing (LCC) tool, moving beyond the traditional priced-focused method. The specific objective to achieve the aim of the study is:

i. To evaluate the most relevant award criterions that best integrate sustainability in it approach between the traditional method (lowest responsive bids) and life cycle costing (LCC) approach.

Achieving this objective will assist in the financial and environmental implications of incorporating LCC in public procurement and evaluate how such an approach can enhance decision-making processes and foster more sustainable development outcomes in Nigeria. Lastly, it will provide a document that could be useful to other researchers and academics intending to undertake research on the life cycle costing (LCC) and public procurement in other African continents'. Considering, the needs to move from more of traditional methods of value for money (savings) in our developmental projects to more of policy objectives that entail sustainability pillars (social, economic and environmental).

2. LITERATURE REVIEW

Theoretical background

The concept of Life Cycle Costing (LCC) originated in the private sector but has gradually been adapted for use in public procurement. LCC is grounded in the principle that the total cost of ownership (TCO) should be considered in decision-making processes, rather than just the initial acquisition cost (Woodward, 1997).
Life Cycle Costing (LCC) is a method used to evaluate the total cost of ownership of a product, service, or system over its entire life cycle, from acquisition to disposal (Woodward, 1997). LCC considers all costs associated with the product or service, including, which include acquisition costs (purchase price, transportation, installation), Operating costs (energy, maintenance, repair), Environmental costs (emissions, waste disposal), Social costs (health, safety, community impact) and End-of-life costs (disposal, recycling, decommissioning), (Woodward, 1997). LCC aims to provide a comprehensive understanding of the total cost of ownership, enabling informed decisions that minimize costs and maximize value (Ellram & Siferd, 1998).
However, Life Cycle costing has different application and usage in different sector, in Construction Project, LCC is used to evaluate the total cost of ownership of buildings and infrastructure projects (Asiedu & Gu, 1998). In Manufacturing LCC is applied to evaluate the total cost of ownership of products and production processes (Ellram & Siferd, 1998). Moreover, in Public Procurement, LCC is used to evaluate the total cost of ownership of goods and services in public procurement (Fregonara et al., 2023). In Energy and Environmental Management, LCC is applied to evaluate the total cost of ownership of energy-efficient solutions and environmental sustainability initiatives (Kaplan & Norton, 1996). While in Transportation: LCC is used to evaluate the total cost of ownership of transportation systems and infrastructure (Thai, 2001).

Bid Evaluation Application in Life Cycle Costing (LCC) in Public Procurement

Bid evaluation is a critical step in the procurement process, where organizations assess and compare bids from different suppliers. In the context of LCC, bid evaluation involves assessing the total cost of ownership of the goods or services being procured. The evaluation of bids in public sector procurement processes has traditionally focused on the initial acquisition costs. However, the Life Cycle Cost (LCC) approach offers a more comprehensive evaluation by considering all costs associated with the acquisition, operation, maintenance, and disposal of assets over their entire lifecycle. The integration of LCC into the bids evaluation process is gaining traction as public sector organisations aim to achieve greater value for money and sustainability.

a. **Acquisition Costs**: Acquisition costs include all expenses related to the procurement of a product or service. These costs cover not only the purchase price but also other associated expenses such as installation, commissioning, and initial training. According to Götze (2011), acquisition costs are a key starting point in LCC because they provide the baseline for further cost evaluations throughout the asset's life. Initial purchase price, transportation, installation, and training costs (Woodward, 1997).
b. **Operating Costs:** Encompasses all expenses related to the day-to-day operation of an asset. This includes energy consumption, labour, consumables, and any other recurring costs that arise from using the asset in its intended capacity. Energy, maintenance, repair, and replacement costs over the asset's lifespan (Asiedu & Gu, 1998).
c. **Environmental Costs:** Environmental costs in LCC refer to the financial implications of a product or service's environmental impact, from production through disposal. According to Hsu and Hu (2018), these costs include expenses related to pollution control, resource depletion, and waste management.
d. **Social Costs:** Social costs in LCC refer to the impacts of a product or service on society, including public health, safety, and well-being. According to Götze (2011), social costs are often less quantifiable than direct financial costs but are crucial for a holistic evaluation. These costs can include issues such as the impact of pollution on local communities or the social implications of labor practices**.** Health, safety, and community impacts (Saad & Zawawi, 2009).
e. **End-of-Life Costs:** Social costs in LCC refer to the impacts of a product or service on society, including public health, safety, and well-being. According to Götze (2011), social costs are often less quantifiable than direct financial costs but are crucial for a holistic evaluation. These costs can include issues such as the impact of pollution on local communities or the social implications of labor practices. Disposal, recycling, or decommissioning costs (Ellram & Siferd, 1998).

Challenges and Strategies for Implementation

Despite recognition of LCC's benefits, several papers identify persistent challenges in its broader implementation. Cole and Sterner (2000) examine the gap between theoretical promises of LCC and its practical applications, discussing strategies to enhance acceptance, especially within green building contexts. Research, by Lim, Zhang, and Oo. (2018), highlights obstacles such as the prioritization of initial costs over life cycle considerations, proposing that government and industry players must support the adoption of LCC practices. One of the most prevailing primary challenges in implementing LCC is the complexity of LCC models and calculations. Götze (2011) discusses how the multifaceted nature of LCC, which includes various, cost categories such as acquisition, operation, maintenance, and end-of-life costs, can make the development and application of LCC models complicated. This complexity can lead to difficulties in accurately forecasting total costs and can require specialized expertise.

Challenges of Adopting Life Cycle Costing (LCC) in Nigeria's Public Procurement

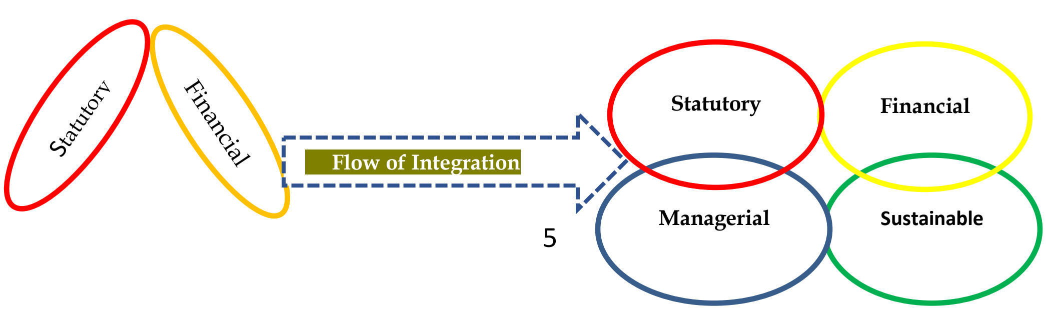
Life Cycle Costing (LCC) is increasingly acknowledged as a pivotal approach for achieving sustainable procurement. However, its adoption remains limited in Nigeria's public sector. Despite the potential benefits of LCC in promoting cost efficiency and sustainability, several barriers hinder its widespread implementation in Nigeria include: Lack of Awareness and Understanding, Institutional and Structural Barriers, Data Availability and Accuracy, Financial Constraints and Budgetary Limitations and cultural and behavioral factors (Oyebanji and Mohammed 2020; Eze and Chinedu 2018; Idowu and Olanrewaju 2019; Ojo and Falola 2018).

Integrating Life Cycle Costing (LCC) method into bid evaluation process

Basically, traditional bids evaluation process concentrate more on costs savings and for a short run term, without any consideration on other factors to incur at the long term run. The public procurement Act 2007 (PPA, 2007) section 19(a) and 19(c) provides how bids should be solicited and evaluated. Based on this requirement, issue of sustainability was not being considered (Figure 2.1), but rather lowest responsive bidder only as the yard stick for selection. Therefore, to achieve an optimum costs savings by organization, tools such as LCC incorporation most be considered (Woodward, 1997). Optimum costs can further viewed in terms of acquiring cost, owing and operating physical assets over their useful lives which serves as a significant cost attached to an assets in any organization (Cardarelli, Baffo, Ubertini & Barbanera, 2022).

However, many researchers shows that integrating LCC into an existing procurement legal framework is not an easy task (Chiurugwi, Udeaje, & Hogg 2010; Arja, Sauce, & Souyri, 2009; Olubodun, Kangwa & Oladapo, 2010; Renda et. al., 2012). But, currently some few countries were able to integrate LCC into their procurement legal framework successfully such as Italy, Denmark and Czech Republic just to mentioned a few (Heralova, 2014). Despite the challenges and barriers in integrating the LCC method as stated in the literature, public organization may consider if not all, but some few aspects of sustainable procurement at both the technical and financial stages of evaluation. These can simply be done through the amendments of the various sections of the PPA, 2007 in the current review of the Act that is ongoing by the joint committee of the national Assembly and the Judiciary. Criteria such as environmental performance, social performance and sustainability consideration should be included at the technical stage.

While at the financial bid evaluation stage factors such as; cost of acquisition, costs of use, maintenance costs, end-of-life costs and costs imputed to environmental externalities linked to the products, services or works during the life cycle should be determined.



Traditional Method Integrated Method

Figure 2.1: Integrating LCC method into the Traditional bid evaluation process

From figure 2.1 it shows the process in which sustainable procurement system can be achieve through the integration of some factors at both the technical and financial stages of the evaluation process. As earlier mentioned the traditional method of the evaluation focuses only on costs savings and other factors, while neglecting the issue of sustainability in the whole process.

3. METHODOLOGY

The study adopted a non-experimental research design also known as case study research design. Case study research strategy comprises process of collecting data such as observation, documents analysis and interview of a particular phenomenon. Case study method refers to complete set of techniques used to carry out a study research, collect and manage data (Lynn, Erens & Sturgis, 2012). The target populations for this study was Federal Polytechnic Bauchi (FPTB) in the North-East Nigeria .The reason for selecting such population is that they are the tertiary institution known to the researcher whom adopted LCC practice in some of their bids evaluation process, and have more access to primary data for the purpose of this study. Considering the nature of the research and the time frame as well as access to the available information needed in the research, a sample size of one (1) tertiary institution was selected.

The purposively selected institution is: Federal Polytechnic Bauchi with each having a project to study from the population of the study. The sample frame consists of all bidding documents, bids evaluation process and award criterion of bidders on the register of Procurement department/works that participated in the bidding process in the past three years (**2021-2023**).

For the purpose of this research, secondary data in the forms of bidding documents, bidders submission documents’ and award criterion recommended for the award of the various projects within the period of study. The documents analysis was designed to address the research questions within the time frame available. Data in the form of currency type, period of project execution, contract sum, project type, assumed life span of projects /supplies and maintenance period

The data collected were analyzed by quantifying the economic performance of a building as a whole. As a main result of the global cost method, the net present value (NPV) is calculated (usually with other synthetic indicators, such as net savings, savings to investment ratio, simple/discounted pay-back period, and adjusted internal rate of revenues, Fregonara, *et.al.*, 2022)

The global cost represents the amount of discounted cash flows of a project option, considering the investment costs, the periodic maintenance, and replacement costs in relation to the lifespan of the components, the energy costs, the end-of-life (dismantling) and disposal costs, and, if present, the eventual residual value of an asset/component. The well-known Equation (1) expresses the formalization of the method:

$C_G(\tau) = C_I + \sum_j * [\sum_{i=1}^{\tau}(C_{ai}\,(j) * R_d(i) - V_{f,\tau}\,(j)]$-----------------------Equation (1)

Where:

C_G (t) = global cost (referred to starting year _0) [N=Naira];

C_I = initial investment costs;

$C_{a,i}(j)$ = annual cost during the year i of component j, which includes annual running costs (energy costs, operational costs, maintenance costs) and periodic replacement costs; dismantling and disposal costs;
Rd (i) = discount factor during the year i;
$V_{f,t}$ (j) = residual value of the component j at the end of the calculation period, referred to the starting year. The discount factor Rd is implied for discounting:

4. ANALYSIS

Table 1: F**eatures of the students' buses Nissan, Innoson and Coscharis**

S/N	Features	Stallion Nissan	Innoson	Coscharis
1	Purchase price (VAT included)	#82,000,000:00	#82,201,000:00	80,500,250:00
2	Equipment version	Trend	Standard	Enjoy
3	Pollution norm	NASRIAL	NASRIAL	NASRIAL
4	CO_2 level (g/km)	104	116	126
5	Motor power (HP)	113	112	105
6	Cylindrical capacity (cm3)	1,200	1,345	1,355
7	Number of engine cylinders	3	4	4
8	Torque (Nm)	110	122	115
9	Engine distribution type	Chain	Belt	Chain
10	Traction type	Front traction	Front traction	Front traction
11	Gearbox	5-Speed manual	5-Speed manual	5-Speed manual
12	Maximum speed (km/h)	240	240	200
13	Acceleration 0-100 km/h (s)	15.0	13.8	18.5
14	Number of doors	4	4	4

15	Fuel used	Gasoline	Gasoline	gasoline
16	Extra-urban consumption(l/100km)	3.7	4.8	5.0
17	Urban consumption (l/100 km)	5.6	6.8	7.4
18	Mixed consumption (l/100 km)	4.4	5.6	5.8
19	Real consumption (l/100 km)	6.4	7.6	7.8
	Fuel tank capacity (liters)	42	50	45
20	Total length (mm)	4,040	4,035	4,021
	Width of the Bus (mm)	1,734	1,734	1,746

Table 2. Discounted maintenance and operation cost for Stallion Nissan Bus (‘000’)

Year/Cost	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Cost of fuel (ltrs)	‘864’	‘864’	‘864’	‘864’	‘864’	‘864’	‘864’	‘864’	‘864’	‘864’
Cost of service inspections	‘450’	‘450’	‘450’	‘450’	‘450’	‘450’	‘450’	‘450’	‘450’	‘450’
Cost of current repairs	‘300’	‘300’	‘300’	‘300’	‘300’	‘300’	‘300’	‘300’	‘300’	‘300’
Cost of the tires	0	‘800’	0	‘800’	‘0	‘800’	0	‘800’	‘0	‘800’
Cost of the batteries	**0**	0	0	‘290’	0	0	0	‘290’	0	0

Cost of Operational insurance	‘1,000’	‘1,000’	‘1,000’	‘1,000’	‘1,000’	‘1,000’	‘1,000’	‘1,000’	‘1,000’	‘1,000’
Cost of Compulsory Insurance	**‘**390**’**	**‘**390**’**	**‘**390**’**	**‘**390**’**	**‘**390**’**	**‘**390**’**	**‘**390**’**	**‘**390**’**	**‘**390**’**	**‘**390**’**
Cost of maintenance and operation	‘3,004’	‘3,804’	‘3,004’	‘4,094’	‘3,004’	‘3,804’	‘3,004’	‘4,094’	‘3,004’	‘3,804’
Discount factor for a =	0.957	0.916	0.876	0.838	0.803	0.768	0.735	0.703	0.673	0.644
Discounted maintenance= and operation cost	‘2,875’	‘3,484’	‘2,632’	‘3,431’	‘2,412’	‘2,921’	‘2,208’	‘2,878’	‘2,022’	‘2,450’
Total discounted maintenance and operation cost	**#27, 313,000:00**									

Table 3. Discounted maintenance and operation cost for Innoson Bus (‘000’)

Year/Cost	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Cost of fuel (ltrs)	**‘**1,026’	**‘**1,026’	‘1,026’	‘1,026’	‘1,026’	‘1,026’	‘1,026’	‘1,026’	‘1,026’	‘1,026’
Cost of service inspections	‘650’	‘650’	‘650’	‘650’	‘650’	‘650’	‘650’	‘650’	‘650’	‘650’
Cost of current repairs	‘400’	‘400’	‘400’	‘400’	‘400’	‘400’	‘400’	‘400’	‘400’	‘400’
Cost of the tires	0	‘800’	0	‘800’	‘0	‘800’	0	‘800’	‘0	‘800’
Cost of the batteries	**0**	0	0	‘290’	0	0	0	‘290’	0	0
Cost of Operational insurance	‘1,200’	1,200’	1,200’	1,200’	1,200’	1,200’	1,200’	1,200’	1,200’	1,200’
Cost of Compulsory Insurance	**‘**580**’**	**‘**580**’**	**‘**580**’**	**‘**580**’**	**‘**580**’**	**‘**580**’**	**‘**580**’**	**‘**580**’**	**‘**580**’**	**‘**580**’**
Cost of maintenance and operation	‘3,456’	‘4,565’	‘3,456’	‘4,946’	‘3’456’	‘4,565’	‘3,456’	‘4,946’	‘3,456’	‘4,565’

Discount factor for a	= 0.957	0.916	0.876	0.838	0.803	0.768	0.735	0.703	0.673	0.644
Discounted maintenance and operation cost	= '3,307'	'4,182'	'3,027'	'4,145'	'2,775'	'3,506'	'2,540'	'3,477'	'2,326'	'2,940
Total discounted maintenance and operation cost				**#32,225,000:00**						

Table 4. Discounted maintenance and operation cost for Coscharis Bus ('000')

Year/Cost	1	2	3	4	5	6	7	8	9	10
Cost of fuel (ltrs)	'1,053'	'1,053'	'1,053'	'1,053'	'1,053'	'1,053'	'1,053'	'1,053'	'1,053'	'1,053'
Cost of service inspections	'600'	'600'	'600'	'600'	'600'	'600'	'600'	'600'	'600'	'600'
Cost of current repairs	'400'	'400'	'400'	'400'	'400'	'400'	'400'	'400'	'400'	'400'
Cost of the tires	0	'800'	0	'800'	'0	'800'	0	'800'	'0	'800'
Cost of the batteries	**0**	0	0	'290'	0	0	0	'290'	0	0
Cost of Operational insurance	'1,200'	1,200'	1,200'	1,200'	1,200'	1,200'	1,200'	1,200'	1,200'	1,200'
Cost of Compulsory Insurance	'580'	'580'	'580'	'580'	'580'	'580'	'580'	'580'	'580'	'580'
Cost of maintenance and operation	'3,833'	'4,633'	'3,833'	'4,923'	'3,833'	'4,633'	'3,833'	'4,923'	'3,833'	'4,633'
Discount factor for a	= 0.957	0.916	0.876	0.838	0.803	0.768	0.735	0.703	0.673	0.644
Discounted maintenance and operation cost	= '3,668'	'4,244'	'3,358'	'4,125'	'3,078	'3,558'	'2,817'	'3,461'	'2,580'	'2,984'
Total discounted maintenance and operation cost				**#33,873,000:00**						

Table 5. Life cycle costs for Nissan, Innoson and Coscharis

S/N	Price/Cost	Stallion Nissan	Innoson	Coscharis

1	Purchase price (VAT included)	#82,000,000:00	#82,201,000:00	80,500,250:00
2	Total discounted maintenance and operation costs (Naira)	#27, 313,000:00	#32,225,000:00	#33,873,000:00
3	**Total Life Cycle Costs for Each**	**109,313,000:00**	**114,426,000:00**	**114,373,250:00**

Table 6. Ranking in case of applying the award criterion "the lowest bidder"
Award Criterion The lowest bids submitted

No.	**Types of Buses**	**Position in ranking**	**Tender Price**
1	Coscharis	1st selected bidder	80,500,250:00
2	Stallion Nissan	2nd Selected Bidder	82,000,000:00
3	Innoson	3rd Selected Bidder	82,201,000:00

Table 7. Ranking in case of application of the award criterion "the lowest Life Cycle Cost bidder"
Award Criterion The lowest bids submitted

No.	**Types of Buses**	**Position in ranking**	**Tender Price including LCC**
1	Stallion Nissan	1st selected bidder	**109,313,000:00**
2	Coscharis	2nd Selected Bidder	**114,373,250:00**
3	Innoson	3rd Selected Bidder	**114,426,000:00**

Table 8. Life cycle costs for Nissan, Innoson and Coscharis based on Resale price of Buses

S/N	**Price/Cost**	**Stallion Nissan**	**Innoson**	**Coscharis**
1	Purchase price (VAT included)	#82,000,000:00	#82,201,000:00	80,500,250:00
2	Total discounted maintenance and operation costs (Naira)	#27, 313,000:00	#32,225,000:00	#33,873,000:00
	Resale price at the end of service life	29,000,000	27,000,000	28,000,000
3	**Total Life Cycle Costs for Each bus**	**80, 313, 000**	**87, 426, 000**	**86, 373, 250**

5. DISCUSSION

<u>Case Study No.1: Supply of Student Buses for local services by the federal polytechnic Bauchi (FPTB)</u>

The institution conducted an analysis for the procurement of three brand new coastal buses for transporting of students' from wunti market to the polytechnic which is being located at gwallamege area in Buachi metropolitan.

Usually, for sustainable purchases the life cycle cost of a product/equipment/machine is much more relevant than the purchase price. There are products on the market that have a low purchase price but have higher life-cycle maintenance and operating costs than other similar products. Calculating life cycle costs and comparing them with the purchase prices can determine which product variant is the best choice. These models are of higher standard and durable, assume to have low fuel consumption and comply with environmental pollution norm. The procurement department in collaboration with works and services unit of the polytechnic considered, the life cycle costs to consists of the purchase price, fuel costs, tires, car batteries, compulsory insurance, optional insurance, periodic inspections/services, accidental current repairs and the resale price (Auction) at the end of operation.

The calculations that follow was based on the hypothesis that students' bus transport student to and fro annually an estimated average run of 15,000 km, the duration of use of the buses being 10 years. Thus, it turns out that the buses travel throughout their lifetime of use a total of 150,000 km. For the three students' buses analyzed by both procurement and works/services department considered the main features as detailed in the Table 1.above.

Therefore, the main costs considered for calculating the life cycle cost (LCC) for each of the three Students' buses are:

A. **The purchase price/cost of supply**

The polytechnic considered the purchase of each of the three different buses for students' transportation from wunti market to gwallamege town as shown in Table 1 above; #82,000,000:00; #82,201,000:00 and #80,500,250:00 (VAT Inclusive all).

B. **Cost of fuel consumed during use**.

These costs to include cost per litre of gasoline @900/ltr, and assume the real conditions of the road traffic in the location were the buses are to be used will consumed fuel at mixed consumption with increase by 2litres per 100km.

Therefore, the costs of fuel consumed during used for the three buses are:

- Stallion Nissan = 15,000 x 900 x(4.4+2)ltrs per 100km= #864,000
- Innoson = 15,000 x 900 x(5.6+2)ltrs per 100km = #1, 026,000
- Coscharis = 15,000 x 900 x (5.8 +2)ltrs per 100km = #1,053,00.

C. **Cost of maintenance and operation**

The cost of maintenance and operation consists of the costs detailed in the following:

- **The cost of service inspections**. Service inspections are performed according to the manufacturer's rules and recommendations annually or when a certain distance is traveled.
- **the cost of current repairs**;
- **the cost of periodically replacing of the tires;**
- **the cost due to the replacement of the batteries**
- **the cost with the compulsory insurance;**
- **the cost with the optional insurance**.

Therefore, item A-C above summed –up the Life Cycle costs for each buses analyzed, in which to select the best optimal that will reduce impact to the society and the environment throughout the

full life cycle of the bus. Furthermore, the legal provisions in practice mention that, in calculating the life cycle cost, all the annual costs related to the operation and maintenance of the vehicles will be taken into account, to which the discount rate for the respective year will be applied, so that all costs will be expressed in the year in which the procurement is made.
Therefore, the level of the discount rate that will be used in 2021 for the award of contracts that use "the lowest cost" award criterion was set at 4.5%. We begin with the computation of the operation and maintenance costs of each bus so as to determine the life cycle cost of each which will inform the next decision action to take by the institution. Table 2-4 shows the detail of each computation.

D. Resale price at end of service life (Auctioning)

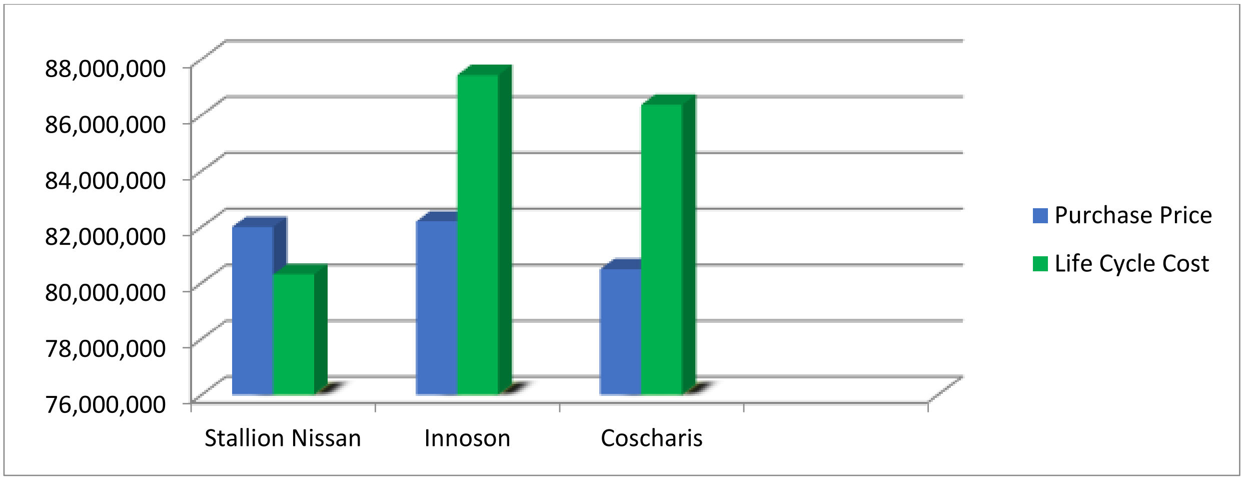
At the end of the service life, the resale price for a 10-year-old Stallion Nissan is **29,000,000** million naira. For the Innoson, this price is **27,000,000** million naira and for the Coscheris is **28,000,000** million naira as shown in Table 8.

At the end of the service life, the resale price is subtracted from the cost calculated on the life cycle, because this value is received by the current owner of the student bus from the next owner, after the completion of the sale-purchase process.

Analysis from the Life Cycle Cost Calculation- First method
The following conclusions are drawn from the data analysis in the table above:
- if the award procedure had been carried out using the award criterion "lowest bidder", based on the Procurement guidelines, the ranking would be the one presented in Table 6. But if the award procedure had been carried out using the award criterion "the lowest life cycle cost bidder", with life cycle cost consideration in the analysis, the ranking would be the one presented in Table 7.
Further analysis can be considered in relation with resale price at the end of service life of each bus in order to compare the two results from different perspective or view. Table 8 below show how the lowest costs bidder will emerge based on Life Cycle Cost method in the analysis.

The graphical representation of purchase prices and life cycle costs is shown in Figure 1. From the figure its show how the initial prices for Coscharis is lower than Nissan and Innoson, but applying the life cycle costs in the initial prices it show a significant rise in the total purchase price which is higher than that of stallion Nissan. Therefore, the institution procurement department simply identified the best bus to purchase for the purposed of transporting students' not just because of lower price, but having less impact to the society and environment throughout the life cycle of the bus and at the same time to achieve value for money as a core objective in the institution. This result aligning with the findings of Dragos & Neamtu, 2014; Heralova, (2019), Götze (2011), Hsu and Hu (2018),

Figure: 4.1. the graphical representation of purchase prices and life cycle costs of the Students' Buses



6. CONCLUSION AND IMPLICATIONS

The bids analysis presents practical method of calculating the life cycle costs for the three bestselling cars in Nigeria based on the recommendation of the NADDC and BPP, as well as a comparison of the situations in which the award criterion was the lowest purchase price or the lowest life cycle cost. It can be seen that the Stallion Nissan car is in the second place of the ranking in the case of applying the criterion lowest purchase price and in the case of applying the award criterion the lowest life cycle cost, more relevant, is in the first place of the ranking.

Therefore, applying Life Cycle Cost method in the analysis or selection of the most advantageous tender among bidders is one of the way in which organization can minimized the effect wrong selection, abandon project, poor quality of supply and maintained social and environmental benefit throughout the life span of the project/equipment as the case may be and attain economy in the long run. With this application the federal polytechnic Bauchi was able to relieve itself from it early challenges being mention in at the beginning of the study and furthermore it enhances it procurement process through selecting the most advantageous bidder among the three participating bidders for the supply.
As such, public organizations are reluctant to promote the application of LCC when analysing and evaluating bids in the award of projects. For wider application of LCC, it seems that Bureau of Public Procurement (BPP), Public organizations and procurement officers play a pivotal role towards changing and regulating developmental projects for economic, environmental and social benefit of people.
.

7. LIMITATIONS AND FURTHER STUDIES

Lastly, it is acknowledged that there are limitations in this study and the findings are indicative and not conclusive. First, the sample size is very small and not representative. However, the findings could further add to the existing knowledge of LCC integration for future studies, whereby a larger sample size should be collected for generalization purpose. Further analyses (such as predictive modelling) should be conducted to examine the role of different actors in procurement on the effective integration of LCC. A cross-culture investigation of LCC application should also be considered in future studies towards identifying exemplar of LCC practices in other government agencies or departments for better comparison.

ACKNOWLEDGEMENTS

The authors would like to thank the procurement Department of the federal polytechnic Bauchi (FPTB) and other co-authors for their valuable contributions towards this paper.

AUTHOR DECLARATIONS

The author declares no conflict of interest.

Author Contributions: Conceptualization, M.L Yahaya., and M.L., Yahaya. Methodology, writing—original draft preparation, M.L Yahaya., and M.L Yahaya., writing—review and editing, Z.A Murtal., funding acquisition, S. L., Abubakar; Supervision, A Muhammad. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding from any organization or individual.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data utilized for this study will be made available upon reasonable request.

Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

Abdullahi, B., Ibrahim, Y.M., Ibrahim, A.D., & Kabir, B., (2019). Developing a Web-Based Tender Evaluation Sysytem Based on Fuzzy Muilt-Attributes Group Decision Making for Nigerian Public Sector Tendering. *World Academy of Science, Engineering and Technology International Journal of Computer and Information Engineering Vol. 13(7)*

Ajaelu, H., Samuel, I.J.O. & Isiofia, L.A., (2021). Assessment of Tendering Processes for Construction Projects and its Effect on Public Project Delivery in Nigeria. *African Research Journal of the Environment, Vol. 4(1)*

Arja, M., Sauce, G., Souyri, B., (2009). External uncertainty factors and LCC: a case study. *Building Research and Information, 37 (3), 325–334.*

Chiurugwi, T., Udeaja, C., Hogg, K., (2010). Exploration of drivers and barriers to life cycle costing (LCC) in construction projects: professional quantity surveyors assessment, in Tizani, W. (Ed.), Computing in Civil and Building Engineering, Proceedings of the International Conference, Nottingham University Press, Nottingham, UK, Paper 108, p. 215.

Cole. R., & Sterner. E., (2000). Reconciling theory and practice of life-cycle costing. *Building Research & Information, Vol. (28*)

Dragoș. D., & Neamțu. B. (2014). Sustainable Public Procurement: Life Cycle Costing (LCC) in the New EU Directive Proposal. *Journal of Public Procurement*.

Ekung, S., Lashinde, A., & Amuda, O., (2015). Assessment of Procurement Parameters for Improving Public Procurement Practice in Nigeria. International Journal of Construction Engineering and Management Vol. 4(5)

Ellram, L. M., & Siferd, S. P. (1998). Total cost of ownership: A key concept in strategic cost management decisions. *Journal of Business Logistics*, *19(1), 55-84*.

Eze, E. S., & Chinedu, O. (2018). Adoption of life cycle costing for sustainable procurement in Nigeria: Challenges and opportunities. *Journal of Public Procurement*, *18*(2), 201-217.

Götze, R. (2011). Life cycle costing in public procurement: A review. *Journal of Cleaner Production*, *19*(7), 710-723

Heralova, R.S., (2014). Life Cycle costing in the preparation of public works contracts. International Scientific Conference: People, Building and Environment (PBE 2014), October 2014, Kroměřiž, Czeck Republic, pp. 15-17.

Hsu, C., & Hu, Y. (2018). The impact of life cycle costing on project performance: A longitudinal study. *International Journal of Project Management*, *36*(2), 271-281

Hunkeler, D., Rebitzer, G., (2003). Life cycle costing: Paving the road to sustainable development? *The International Journal of Life Cycle Assessment, 8, 109–110*

Idowu, A., & Olanrewaju, I. (2019). Data management challenges in the implementation of life cycle costing in Nigeria's public sector. *Journal of Construction Engineering and Management*, *145*(7),

Kaplan, R. S., & Norton, D. P. (1996). Linking the balanced scorecard to strategy. *California Management Review, 39(1), 53-79.*

Lim. B., Zhang. W., & Oo. B., (2018). Sustainable Procurement in Australia: Quantity Surveyors' Perception on Life Cycle Costing. *International Journal of Integrated Engineering Vol. (10)*

Naiyeju, E.A., Ogedengbe, I.T., & Aderoba, A.A., (2013). Standardization of Bid Evaluation in the Upstream Sector of the Nigeria Oil and Gas Industry. *Journal of Emerging Trends in Engineering and Applied Sciences Vol. 4(3)*

Olander, S., & Norinder, H., (2024). Using Past Performance as an Award Criteria in EU Public Procurement. 12th Nordoc Conference on Construction Economics and Organization: In IOP Conference Series: Earth and Environmental Science 1389

Olubodun, F., Kangwa, J., Oladapo, A., Thompson, J., (2010). An appraisal of the level of application of life cycle costing within the construction industry in the UK. *Structural Survey, 28 (4), 254–265*

Orfanidou., V. S., N. Rachaniotis., N., Tsoulfas., G., & Chondrokoukis., G., (2023). Life Cycle Costing Implementation in Green Public Procurement: A Case Study from the Greek Public Sector. *Journal of Sustainability*

Oyebanji, A. A., & Mohammed, A. (2020). Financial constraints and the adoption of life cycle costing in Nigerian public procurement. *Public Budgeting & Finance, 40*(1), 25-42.

Oyediran, O.S., & Akintola, A.A., (2011). A Survey of the State of the Art of E-tendering in Nigeria. *Journal of Information Technology in Construction Vol. 16*

Ozyurek, I., & Erdal, M., (2018). Assessment of Qualification Criteria Described in Public Procurement Law Code 4734 in Construction Works by Analytic Hierarchy Processes (AHP). *Gazi University Journal of Science Vol. 31(2)*

Ozyurek, I., & Erdal, M., (2023). Solution Proposals based on Fuzzy AHP-TOPSIS Hybrid Model to the Problem in Public Works Procurement in Turkey. *Turkish Journal of Civil Engineering*

Plebankiewicz, E., & Kozik, R., (2017). The Transformation of the Tender Evaluation Process in Public Procurement in Poland: IOP Conference Series: Material Science and Engineering 251

Plebankiewicz, E., (2024). Procedures for Awarding Work Contract in Europe. *Building 2024, 14 883*

Renda, A., Pelkmans, J., Egenhofer, C., Schrefler, L., Luchetta, G., Selcuki, C., Ballesteros, J., Zirnhlet, A.C., 2012. The Uptake of Green Public Procurement in the EU27. Main Report. Centre for European Policy Studies (CEPS) and College of Europe (CoE), 29 February 2012.

Sope Williams-Elegbe (2015). A Comparative Analysis of the Nigerian Public Procurement Act Against International Best Practice. *Journal of African Law, 59, pp 85-98*

Suleiman, S., Saidu, I.I., Adamu, A.D. & Tsado, A.J., (2024). Management of Bid Evaluation Risks in Procurement of Construction Projects of Public Tertiary Institution in Nigeria. *Environmental Technology and Science Journal 15(1)*

Woodward, D. G. (1997). Life cycle costing - theory, information acquisition and application. *International Journal of Project Management, 15(6), 335-344*.

Yahaya, M. L., Oyediran,O.S., & Onukwube, H.N (2019). Challenges of PPA 2007 in the Implementation of Government Policies Related to the Construction Industry. *Journal of Civil and Construction Engineering Vol. 5(3)*