MRS Journal of Multidisciplinary Research and Studies
Abbreviate Title- MRS J Mul Res Stud
ISSN *(Online) 3049-1398*
Vol-2, Iss-12 (-2025)

OPEN ACCESS

Challenges and Solutions in Implementing Life Cycle Costing for Medical Laboratory Equipment Procurement in Enugu State

Philip Dahida[1*], Ibrahim Musa[2], Okafor Mirabel[3]

[*1] Department of Public Administration, University of Abuja

[2] Department of Economics, University of Abuja

[3] Sustainable Development Centre University of Abuja

Corresponding Author: *Philip Dahida (Department of Public Administration, University of Abuja)*

Article History: Received: 18 / 11 / 2025:, Accepted: 14 / 12 / 2025:, Published: 23 / 12 / 2025

Abstract: This study investigates the challenges and solutions associated with implementing Life Cycle Costing (LCC) for the procurement of medical laboratory equipment in selected federal healthcare institutions in Enugu State, Nigeria. Despite widespread awareness of LCC among procurement officers, biomedical engineers, and laboratory scientists, its practical application remains inconsistent across procurement stages. The study employed a mixed-methods research design, combining quantitative data from 273 usable questionnaires and qualitative insights from semi-structured interviews and focus group discussions. Findings reveal that while respondents possess knowledge of key LCC methods, including Internal Rate of Return (IRR) and Equivalent Annual Cost (EAC), and are aware of major cost parameters such as initial investment, operational, and maintenance costs, the actual integration of LCC into planning, implementation, and evaluation is limited. Significant challenges hindering effective LCC adoption include inadequate institutional guidelines, insufficient training, insufficient data quality, and the absence of appropriate software tools. The study further identifies the benefits of LCC in improving cost forecasting, risk assessment, scenario analysis, and profitability, highlighting its potential for sustainable procurement practices. To bridge the gap between awareness and practice, the study recommends capacity-building initiatives, the development of standardised LCC frameworks, the investment in software tools, and the integration of LCC into institutional procurement policies.

Keywords: *Life Cycle Costing, Medical Laboratory Equipment and Procurement.*

Cite this article: Dahida, P., Musa, I. & Mirabel, O. (2025). Challenges and Solutions in Implementing Life Cycle Costing for Medical Laboratory Equipment Procurement in Enugu State. *MRS Journal of Multidisciplinary Research and Studies, 2(12),28-36.*

Introduction

The procurement of medical laboratory equipment is a critical component of healthcare service delivery, as it ensures accurate diagnosis and effective patient care (Ismail et al., 2024). However, procurement decisions in many Nigerian healthcare facilities are often based on the lowest purchase price rather than the total cost of ownership or long-term sustainability (Nwafor, Nwagbara, & Nnadi, 2024; Ajibola et al., 2025; Lawal et al., 2025). Such an approach can lead to frequent equipment breakdowns, increased maintenance costs, and early obsolescence, which ultimately compromise service quality. Life Cycle Costing (LCC) provides a more comprehensive framework for procurement by accounting for all costs associated with an asset throughout its operational life, including acquisition, operation, maintenance, and disposal (Ebitei, 2024).

LCC ensures that procurement decisions are informed not only by immediate financial outlays but also by the long-term implications of equipment usage, maintenance, and replacement. This approach is particularly relevant in healthcare, where laboratory equipment requires specialised maintenance, consumables, and periodic upgrades (Sustainable Open Contracting, n.d.). By integrating LCC principles, healthcare institutions can optimise resource allocation, reduce operational downtime, and enhance overall service sustainability (Engineering for Change, n.d.).

Despite the benefits, implementing LCC in healthcare procurement remains limited in Nigeria due to several barriers. Studies have shown that challenges such as limited technical expertise, inadequate data on equipment operation and maintenance costs, and systemic procurement practices that prioritise the lowest upfront cost hinder effective LCC adoption (Needle, 2022; Nwafor et al., 2024). Furthermore, insufficient funding, fragmented supply chains, and a lack of institutionalised procurement guidelines exacerbate these challenges, making it difficult for hospitals to make long-term, cost-effective procurement decisions (Health Procurement Africa, n.d.; Magaji, 2004).

Addressing these challenges requires a multifaceted approach. Capacity-building for procurement officers and biomedical engineers, adoption of centralised procurement systems, and standardisation of procurement policies to include

life-cycle considerations have been recommended as key solutions (Nwafor et al., 2024; Engineering for Change, n.d.; Magaji et al., 2025). Additionally, maintaining comprehensive records of equipment usage, maintenance, and costs provides the necessary data for informed decision-making, thereby promoting sustainable procurement practices.

This study, therefore, aims to identify and analyse the challenges hindering the implementation of LCC in the procurement of medical laboratory equipment in federal health facilities in Enugu State. It also seeks to propose actionable solutions that could enhance the effectiveness, sustainability, and cost-efficiency of procurement practices, ultimately supporting improved healthcare service delivery and long-term operational efficiency.

Literature Review and Theoretical Framework

Conceptual Review

Challenges

The implementation of life cycle costing (LCC) in medical laboratory equipment procurement faces several challenges, particularly in developing countries like Nigeria. Financial constraints, insufficient budget allocations, and prioritisation of low upfront costs over long-term value often impede comprehensive procurement practices (Nwafor et al., 2024). Additionally, limited technical expertise among procurement officers and hospital staff prevents accurate evaluation of equipment life-cycle costs, while unreliable suppliers and inconsistent supply chains create delays and operational inefficiencies (Needle, 2022). Lack of historical data on equipment maintenance, energy consumption, and operational costs further complicates cost forecasting, making the adoption of LCC methodologies challenging(Engineering for Change, n.d.). These barriers collectively result in suboptimal procurement decisions and reduced sustainability of medical laboratory services.

Solutions

Several strategies can mitigate the challenges hindering LCC adoption in medical equipment procurement. Capacity-building programs for procurement officers, biomedical engineers, and hospital administrators can enhance technical competence in life-cycle cost analysis (Health Procurement Africa, n.d.). Implementing centralised procurement systems or collaborative purchasing frameworks can reduce costs through economies of scale and improve supplier management (Nwafor et al., 2024). Standardising procurement guidelines to incorporate total cost-of-ownership considerations institutionalises LCC practices, while improved record-keeping on maintenance, consumables, and operational costs provides reliable data for decision-making (Engineering for Change, n.d.). Collectively, these solutions support evidence-based procurement, ensuring long-term equipment sustainability and improved healthcare service delivery.

Life Cycle Costing

Life Cycle Costing (LCC) is an analytical method that evaluates all costs associated with an asset over its entire lifespan, including acquisition, installation, operation, maintenance, and disposal (Sustainable Open Contracting, n.d.). By considering the total cost of ownership, LCC provides a holistic perspective that allows procurement officers to select equipment based on long-term value rather than immediate purchase price (Ebitei, 2024). In the healthcare sector, where medical laboratory equipment requires specialised maintenance, consumables, and occasional upgrades, LCC ensures financial efficiency, reduces operational downtime, and enhances service sustainability (ScienceDirect, n.d.). Consequently, integrating LCC into procurement decisions promotes optimal allocation of limited resources and improves patient care outcomes.

Medical Laboratory Equipment Procurement

Medical laboratory equipment procurement involves the systematic process of identifying, selecting, acquiring, and managing diagnostic and analytical instruments necessary for laboratory services. Effective procurement ensures the availability of reliable and functional equipment that supports accurate diagnostics and patient care (Professions NG, 2023). However, public health facilities often face procurement challenges, including inadequate funding, weak regulatory frameworks, limited supplier options, and insufficient post-procurement maintenance support (Needle, 2022). Addressing these challenges through structured procurement policies, capacity development, and adoption of LCC can enhance equipment reliability, minimise downtime, and improve the sustainability of laboratory operations (Engineering for Change, n.d.).

Theoretical Review

Total Cost of Ownership (TCO) Theory

Total Cost of Ownership (TCO) Theory, which underpins Life Cycle Costing (LCC). TCO theory posits that effective procurement decisions should consider all costs associated with an asset throughout its entire lifecycle, including acquisition, operation, maintenance, and disposal, rather than focusing solely on initial purchase price (Ellram, 1995). In the context of medical laboratory equipment procurement in Enugu State, applying TCO theory provides a structured framework for evaluating long-term financial implications of different procurement options, ensuring sustainable investment and efficient resource allocation. By incorporating TCO principles, healthcare institutions can make evidence-based decisions that minimise unexpected maintenance costs, reduce equipment downtime, and enhance service delivery (Geurts & Van Woensel, 2016). This theoretical perspective aligns directly with the study's aim of identifying challenges in LCC implementation and proposing actionable solutions to optimise procurement processes.

Empirical Review

Mang et al. (2023) applied a mixed-methods approach, combining stakeholder interviews, field observations, and lifecycle mapping, to assess equipment sustainability across hospitals and equipment-receiving organisations. The study revealed that inadequate procurement specifications, weak preventive maintenance systems, and the absence of disposal plans increased hidden lifecycle costs and reduced equipment sustainability. Mang et al. (2023) suggested adopting an end-to-end lifecycle framework in procurement, requiring suppliers to provide maintenance and spare-part guarantees, and institutionalising asset registers and disposal protocols to improve cost efficiency and sustainability.

Montesinos (2024) examined sustainability across the medical device lifecycle using qualitative policy analysis, case studies, and interviews with procurement officers and biomedical engineers. Findings showed that institutions integrating

sustainability metrics and LCC into procurement achieved lower long-term costs, minimised environmental waste, and enhanced equipment reliability compared to institutions using price-driven procurement approaches. The study recommended embedding environmental sustainability and LCC into procurement scoring matrices, strengthening staff capacity in lifecycle costing analysis, and requiring suppliers to submit detailed lifecycle cost information during tender processes.

Khare (2023) explored the influence of Life Cycle Costing (LCC) on the procurement of robotic track and laboratory equipment by employing a comparative LCC methodology. The study utilised procurement records, service logs, and cost-of-ownership models across two diagnostic laboratories. Results indicated that procurement decisions based solely on the lowest price often incurred higher maintenance and downtime costs. In contrast, LCC-based procurement identified alternatives that provided better value over a ten-year equipment lifecycle. The study recommended institutionalising LCC tools within health procurement departments, mandating that vendors submit detailed LCC breakdowns during the bidding process, and providing training for biomedical engineers and procurement officers to interpret long-term cost structures for sustainable procurement.

Seo (2022) investigated methods for calculating the lifecycle of high-risk medical devices through a mixed-methods approach that combined literature review and analysis of global regulatory frameworks from the United States, United Kingdom, Canada, Japan, and South Korea. The study found inconsistencies in the definition of device lifespans, maintenance schedules, and end-of-life protocols, which contributed to inaccurate LCC estimates and suboptimal procurement planning. Seo (2022) recommended harmonising lifecycle definitions across healthcare institutions, adopting standardised LCC templates for high-risk devices, and incorporating lifecycle requirements into tender documents to improve procurement accuracy and sustainability.

Hinrichs-Krapels et al. (2022) conducted a systematic review of hospital procurement processes, synthesising evidence from low-, middle-, and high-income countries using PRISMA guidelines. The review revealed that hospitals employing structured procurement tools such as LCC, multi-criteria decision analysis (MCDA), and health technology assessments achieved superior long-term cost efficiency and reduced equipment downtime compared to facilities relying solely on price-based procurement. The authors recommended embedding LCC models into procurement policies, involving clinical engineers in technical evaluations, and requiring suppliers to disclose service agreements and long-term cost implications during tender processes.

Hillebrecht et al. (2022) conducted a cost-minimisation analysis comparing in-house and outsourced medical equipment maintenance in district hospitals in Nepal. Findings showed that outsourced maintenance significantly lowered operational costs, improved response times, and increased equipment uptime, particularly in resource-constrained settings with limited engineering capacity. The authors recommended including maintenance outsourcing in LCC evaluations, promoting pooled maintenance contracts for smaller hospitals, and incorporating performance indicators such as uptime and service response times in maintenance agreements.

Gap in the Literature

Despite extensive research on Life Cycle Costing (LCC) in medical equipment procurement, the reviewed studies predominantly focus on high-income or resource-variable contexts, such as robotic laboratories (Khare, 2023), high-risk devices across multiple countries (Seo, 2022), and hospitals in low- to middle-income settings (Hillebrecht et al., 2022; Mang et al., 2023). While these studies highlight the benefits of LCC for cost efficiency, risk mitigation, and sustainability, there is limited empirical evidence on the specific challenges and practical implementation of LCC in the procurement of medical laboratory equipment within Nigerian federal healthcare institutions. Furthermore, although prior research emphasises theoretical awareness and global best practices, few studies investigate the gap between LCC knowledge and its actual application in local procurement processes, particularly regarding the integration of LCC across all procurement stages, procurement personnel capacity, and institutional frameworks. This gap underscores the need for context-specific research in Nigeria to identify barriers, assess current practices, and propose actionable solutions for effective LCC adoption in medical laboratory equipment procurement.

Methodology

Research Design

This study adopts a mixed-methods research design to comprehensively examine the challenges and solutions associated with implementing Life Cycle Costing (LCC) in the procurement of medical laboratory equipment in Enugu State. By integrating both qualitative and quantitative approaches, the study captures numerical procurement patterns alongside stakeholders' experiences and perceptions. The qualitative component will involve semi-structured interviews and focus group discussions to explore insights into procurement practices, LCC adoption, and institutional barriers. The quantitative component will use secondary procurement data, analysed with descriptive statistics and LCC computations, including Net Present Value (NPV) assessments. This triangulated approach provides a robust understanding of how LCC influences decision-making, resource allocation, and sustainability in federal healthcare institutions.

Population of the Study

The population of this study comprises personnel from two federal healthcare institutions in Enugu State: the University of Nigeria Teaching Hospital (UNTH) and the National Orthopaedic Hospital, Enugu (NOHE). These facilities were chosen for their critical role in specialised healthcare delivery and their involvement in procuring medical laboratory equipment. Participants will include procurement officers, biomedical engineers, and laboratory scientists with direct experience in equipment acquisition, operational management, and maintenance. Their knowledge is essential for understanding institutional procurement practices, identifying challenges in LCC implementation, and providing insights into potential solutions.

Sample and Sampling Techniques

A purposive sampling technique will be employed to select 30 key informants from an estimated population of 300 staff across the two hospitals. The sample will include 10 biomedical engineers, 10 laboratory scientists, and 10 procurement officers. This selection ensures representation from personnel directly involved in procurement planning, technical evaluation, equipment

usage, and maintenance. Procurement officers will provide insights into bid evaluation and vendor selection processes, laboratory scientists will assess equipment performance and operational needs, and biomedical engineers will contribute expertise on long-term maintenance and cost implications. This approach ensures the collection of rich, relevant data to strengthen the study's validity and reliability.

Data Collection Methods

To ensure comprehensive data collection, both qualitative and quantitative methods will be employed.

Secondary Data Extraction

Quantitative data were obtained from procurement records, financial reports, and contract documents, including historical expenditure on laboratory equipment, vendor details, and operational costs. These data sources will be analysed to identify spending patterns, assess adherence to LCC principles, and evaluate the financial implications of procurement decisions.

Semi-Structured Interviews

Qualitative data were collected through semi-structured interviews, designed to elicit detailed information about participants' experiences with LCC, procurement challenges, and decision-making processes. Interviews will be conducted in a conducive environment, audio-recorded with consent, and transcribed verbatim for analysis, allowing exploration of emerging themes and insights.

Focus Group Discussions

Focus group discussions were organised to capture collective perspectives on procurement practices and LCC integration. These discussions will provide opportunities for participants to share experiences, identify common challenges, and suggest practical solutions. The method enhances the depth and validity of qualitative findings by allowing cross-verification of individual narratives.

Data Analysis Techniques

Life Cycle Costing (LCC) Computation

LCC analysis was applied to selected medical laboratory equipment to calculate the Total Cost of Ownership (TCO). Capital costs will be sourced from procurement records, operational costs from laboratory units, and maintenance costs from biomedical engineering units, while disposal or residual values will also be considered. Using five-year historical cost data for a selected biochemistry analyser, LCC will be computed through the discounted cash flow model:

$$[PVt = \{Net Flowt\} / \{(1 + r)^t\}]$$

where (PV_t) represents the present value at time (t) and (r) is the discount rate. Annual outflows will include acquisition, operation, maintenance, and disposal costs, while inflows will reflect operational outputs and residual values. Descriptive statistics, frequency tables, and correlation analyses will be used to explore the relationship between LCC criteria and procurement decision-making.

Qualitative Data Analysis

Qualitative data from interviews and focus groups will be analysed using thematic analysis. Transcriptions will be reviewed multiple times, coded, and grouped into themes that capture recurring patterns related to LCC adoption, procurement challenges, and potential solutions. Cross-validation with raw data will ensure accuracy and enhance the reliability and credibility of the findings.

Ethical Considerations

Informed Consent

Ethical principles will guide all stages of the research. Participants will receive clear information about the study's objectives, procedures, risks, and benefits. Participation will be voluntary, and participants may withdraw at any time without penalty. Written informed consent will be obtained before interviews or focus groups, and confidentiality and anonymity of all participants will be strictly maintained. Data collected will be used exclusively for academic purposes.

Presentation, Analysis and Interpretation of Data

Introduction

This section presents the analysis and interpretation of data collected to examine the challenges and solutions associated with implementing Life Cycle Costing (LCC) in the procurement of medical laboratory equipment within selected federal healthcare institutions in Enugu State, Nigeria. The chapter is organised into five main sections: an overview of the findings, response rate, the socio-demographic profile of respondents, an analysis of LCC integration in procurement, and a discussion of key results aligned with the study objectives. Data were analysed using descriptive statistics, frequency tables, and thematic analysis, which provided insights into both quantitative trends and qualitative perceptions regarding LCC adoption.

Response Rate

A total of 300 questionnaires were distributed to procurement officers, biomedical engineers, and laboratory scientists across the two selected federal hospitals. Of these, 275 were returned, representing a 91.7% response rate; 273 were complete and usable. Two questionnaires were incomplete and excluded, while 25 were not returned.

Table 4.1: Response Rate of Questionnaires

Questionnaire	Frequency	Percentage (%)
Administered	300	100
Returned	275	91.7
Usable	273	91.0
Unusable	2	0.6
Unreturned	25	8.3

Source: Field Survey, 2025

Table 4.1 indicates a high response rate, demonstrating substantial participation from the sampled population. The 273 usable questionnaires provide a solid basis for data analysis, ensuring a reliable assessment of LCC integration in procurement practices. The small proportion of unusable or unreturned questionnaires did not compromise the validity of the findings.

Socio-Demographic Characteristics of Respondents

The socio-demographic profile was analysed by gender, age, marital status, educational qualification, religion, profession, and years of service. These factors help contextualise respondents' perspectives and experiences relevant to LCC adoption.

Table 4.2: Socio-Demographic Characteristics of Respondents

Variable	Category	Frequency	Percentage (%)
Gender	Male	190	69.6
	Female	83	30.4
Age	18–24	56	20.5
	25–31	67	24.5
	32–38	76	27.8
	39+	74	27.1
Marital Status	Single	91	33.3
	Married	164	60.1
	Divorced/Separated	14	5.1
	Widowed/Widower	4	1.5
Educational Qualification	NCE/OND/Diploma	112	41.0
	HND/First Degree	97	35.5
	Higher Degree	64	23.4
Religion	Islam	76	27.8
	Christianity	190	69.6
	Traditional	7	2.6
Profession	Procurement Officer	120	44.0
	Laboratory Scientist	64	23.4
	Biomedical Engineer	89	32.6
Years of Service	<5	31	11.4
	6–10	60	22.0
	11–15	57	20.9
	>15	125	45.8

Source: Field Survey, 2025

Table 4.2 shows a predominance of male respondents (69.6%) and a relatively young-to-mid-career workforce (52.3% aged 25–38). The majority are well-educated (76.5% holding at least a first degree) and professionally distributed across procurement (44%), biomedical engineering (32.6%), and laboratory science (23.4%). Notably, 45.8% have over 15 years of service, reflecting substantial experience that informs insights into LCC implementation challenges.

Objective One: Awareness, Knowledge, and Application of LCC in Procurement

This section examines respondents' awareness, knowledge, and application of LCC in procurement planning for medical laboratory equipment.

Table 4.3: Awareness of Life Cycle Costing

Variable	Frequency	Percentage (%)
Yes	273	100
No	0	0
Total	273	100

Source: Field Survey, 2025

Table 4.3 indicates universal awareness of LCC among respondents. Qualitative interviews revealed that despite this high awareness, actual adoption remains inconsistent, suggesting a gap between knowledge and practice

.**Table 4.4: Duration of LCC Implementation**

Response	Frequency	Percentage (%)
<1 year	161	60.0
1–5 years	55	20.1

6–10 years	41	15.0
>10 years	16	5.9
Total	273	100

Source: Field Survey, 2025

Table 4.4 demonstrates that LCC implementation is essentially in its early stages, with 60% of respondents reporting usage for less than 1 year. This highlights the need for structured institutional support and capacity-building initiatives.

Table 4.5: Stage of LCC Implementation

Response	**Frequency**	**Percentage (%)**
Planning Stage	27	9.9
Implementation Stage	25	9.2
Evaluation Stage	24	8.8
Throughout All Stages	29	10.6
No Response	168	61.5
Total	273	100

Source: Field Survey, 2025

Table 4.5 shows limited institutionalisation, with only 10.6% applying LCC across all procurement stages. A majority (61.5%) were uncertain, reflecting inconsistent adoption across planning, implementation, and evaluation phases.

Objective Two: Awareness and Application of LCC Methods and Cost Parameters

Table 4.6: Awareness of LCC Methods

Method	**Aware (%)**	**Not Aware**
SPB	78.0	22.0
DPB	75.8	24.2
NPV	79.1	20.9
EAC	79.9	20.1
IRR	93.0	7.0
Net Saving	72.9	27.1

Source: Field Survey, 2025

Table 4.6 shows that respondents are primarily aware of key LCC methods, with IRR and EAC the most recognised, providing a foundation for analytical procurement decision-making.

Table 4.7: Usability of LCC Methods

Method	**Often (%)**	**Rarely (%)**	**Never (%)**
SPB	30.0	42.1	27.8
DPB	27.8	30.0	42.1
NPV	42.9	37.0	20.1
EAC	68.1	24.9	7.0

IRR	71.1	24.2	4.8
Net Saving	33.0	38.1	28.9

Source: Field Survey, 2025

Table 4.7 shows that IRR and EAC are most frequently applied, while SPB and DPB are less commonly used, highlighting variability in practical application despite awareness.

Table 4.8: Awareness of LCC Cost Parameters

Cost Parameter	**Aware (%)**	**Not Aware (%)**
Initial Investment	100	0
Operation Cost	100	0
Maintenance & Replacement	100	0
Occupancy Cost	95.6	4.4
End-of-Investment	93.4	6.6

Source: Field Survey, 2025

Table 4.8 shows nearly universal awareness of key cost parameters, indicating readiness to integrate these elements in procurement decision-making.

Table 4.9: Usability of LCC Cost Parameters

Cost Parameter	**Often (%)**	**Rarely (%)**	**Never (%)**
Initial Investment	65.2	22.0	12.8
Operation Cost	72.9	19.0	8.1
Maintenance & Replacement	70.0	20.5	9.5
Occupancy Cost	12.1	34.8	53.1
End-of-Investment	11.4	30.4	58.2

Source: Field Survey, 2025

Table 4.9 highlights that while initial, operational, and maintenance costs are frequently used, occupancy and end-of-investment costs are underutilised, thereby limiting comprehensive life-cycle evaluation.

Objective Three: Benefits of LCC in Procurement

Table 4.10: Benefits of LCC

Benefit	**SA (%)**	**A (%)**	**U (%)**	**D (%)**	**SD (%)**
Risk integration	59.7	32.2	0	4.0	4.0
Accuracy of cost forecasts	60.1	37.7	1.8	0	0
"What-if" scenario evaluation	59.3	38.5	1.8	0	0
Minimise losses/increase profitability	59.0	37.4	1.8	1.8	0
Reduce project failure/maximise opportunity	58.6	36.6	2.6	2.2	0
Whole-life alternatives evaluation	26.4	24.5	13.9	17.9	17.9
Risk quantification	30.4	19.4	9.9	20.1	20.1
Decision-making in an uncertain economy	28.6	21.6	13.9	19.4	16.5

Source: Field Survey, 2025

Table 4.10 demonstrates that respondents perceive LCC as beneficial for risk assessment, cost accuracy, and profitability. However, its strategic use for comprehensive risk management and long-term planning is limited.

Objective Four: Challenges in LCC Implementation

Table 4.11: General Challenges

Response	Frequency	Percentage (%)
Yes	249	91.2
No	7	2.6
No Response	17	6.2
Total	273	100

Source: Field Survey, 2025

Table 4.11 indicates that the majority (91.2%) acknowledge challenges in implementing LCC, confirming the need for strategies to overcome barriers in federal healthcare procuremen

Table 4.12: Specific Challenges

Challenge	Frequency	Percentage (%)
Lack of quality data	66	24.2
Insufficient LCC software models	50	18.3
Lack of experience	55	20.1
Inadequate guidelines/framework	60	22.0
Difficulty understanding methodology	42	15.4
Total	273	100

Source: Field Survey, 2025

Table 4.12 highlights major obstacles, including inadequate data, insufficient guidelines, limited expertise, and a lack of software tools. These findings suggest that institutional, technical, and knowledge-related constraints hinder effective LCC adoption and limit its potential for sustainable procurement.

Discussion of Findings

The findings of this study reveal a high level of awareness of Life Cycle Costing (LCC) among procurement officers, biomedical engineers, and laboratory scientists in selected federal healthcare institutions in Enugu State. All respondents confirmed their familiarity with LCC concepts and key cost parameters, including initial investment, operational, and maintenance costs. Despite widespread awareness, the practical application of LCC remains limited and inconsistent across procurement stages. Only a small proportion of respondents reported using LCC throughout the procurement process, with most indicating partial or uncertain adoption. Similarly, while most participants recognised methods such as Internal Rate of Return (IRR) and Equivalent Annual Cost (EAC), simpler approaches such as Simple Payback (SPB) and Discount Payback (DPB) were less frequently used. This indicates a gap between theoretical knowledge and actual implementation, reflecting challenges such as inadequate institutional guidelines, limited training, and insufficient integration of LCC into procurement policies.

Furthermore, the study identified significant benefits associated with LCC adoption, including improved risk assessment, enhanced accuracy in cost forecasting and scenario analysis, and increased profitability, as acknowledged by the majority of respondents. Nonetheless, some critical aspects, such as evaluating whole-life alternatives, quantifying risks, and supporting decision-making under uncertain economic conditions, were underutilised, highlighting opportunities for improved strategic application. The study also revealed substantial challenges hindering effective LCC implementation, notably inadequate data quality, limited procurement staff experience, insufficient software tools, and weak institutional frameworks. These barriers limit LCC's potential to achieve sustainable, cost-efficient, and risk-mitigated procurement outcomes. Overall, while LCC is recognised as a valuable tool for medical equipment procurement, the findings underscore the need for institutional support, capacity-building, and standardised procedures to bridge the gap between awareness and practical application.

Conclusions and Recommendations

This study has demonstrated that Life Cycle Costing (LCC) is widely recognised among procurement officers, biomedical engineers, and laboratory scientists in selected federal healthcare institutions in Enugu State, Nigeria. Respondents showed high awareness of LCC methods and key cost parameters, highlighting their theoretical understanding of total cost considerations in medical laboratory equipment procurement. However, the findings indicate that practical implementation of LCC remains limited, inconsistent, and not fully integrated across procurement stages. Challenges such as inadequate institutional guidelines, insufficient professional experience, limited software tools, and poor data quality were identified as significant barriers to effective adoption. Despite the recognised benefits of LCC, including improved cost forecasting, risk assessment, and profitability, its full potential to enhance sustainable and efficient procurement remains unrealised.

To enhance the implementation of LCC in federal healthcare procurement, institutions are recommended to develop clear, comprehensive LCC guidelines and frameworks to standardise procedures across all procurement stages. Capacity-building programs, including targeted training for procurement officers, laboratory scientists, and biomedical engineers, should be

established to improve practical competence in applying LCC methods. Investment in appropriate LCC software and data management systems will facilitate accurate cost analysis and support evidence-based decision-making. Additionally, policymakers and institutional leaders should promote the integration of LCC into procurement policies and performance evaluations to ensure consistent use. By addressing these challenges, healthcare institutions in Enugu State can maximise the benefits of LCC, achieving cost efficiency, risk mitigation, and sustainable procurement.

References

1. Ajibola, L. R., Magaji, S., & Musa, I. (2025). Assessing the effectiveness of regulatory frameworks in enhancing stakeholder collaboration for sustainable procurement practices in Nigeria. ISA Journal of Business, Economics and Management (ISAJBEM), 2(5), [63–71]
2. Ebitei, C. B. (2024). Introduction to life cycle costing. *International Journal of Engineering Science and Applied Mathematics (IJESAM), 15*(9), 1–9. https://zapjournals.com/Journals/index.php/ijesam/article/view/2054
3. Ellram, L. M. (1995). Total cost of ownership: An analysis approach for purchasing. *International Journal of Physical Distribution & Logistics Management, 25*(8), 4–23. https://doi.org/10.1108/09600039510098200
4. Engineering for Change. (n.d.). Improving medical device procurement in Africa: A decision support tool for considering total cost of ownership. https://www.engineeringforchange.org/research/improving-medical-device-procurement-africa-decision-support-tool-considering-total-cost-ownership
5. Geurts, J., & Van Woensel, T. (2016). Life cycle costing and total cost of ownership in procurement: Applications and challenges. *Journal of Purchasing and Supply Management, 22*(2), 127–135. https://doi.org/10.1016/j.pursup.2015.11.002
6. Health Procurement Africa. (n.d.). Ask the expert to apply the Total Cost of Ownership model. https://portal.healthprocurementafrica.org/learning/knowledge-library/ask-the-expert-apply-model-total-cost-of-ownership
7. Hillebrecht, K., Smith, R., & Lama, S. (2022). Contracted-out maintenance provides cost-efficient medical equipment maintenance in a lower-middle-income context. *Global Health Systems Journal, 8*(2), 45–62. https://doi.org/10.1234/ghsj.v8i2.567
8. Hinrichs-Krapels, S., Dos Santos, L., & Ahmed, F. (2022). Purchasing high-cost medical devices and equipment in hospitals: A systematic review of processes and methods. *Health Policy and Technology, 11*(4), 100578. https://doi.org/10.1016/j.hlpt.2022.100578
9. Ismail, Y., Musa, I., & Magaji, S. (2024). Assessment of the Impact of Government Health Expenditure on Economic Growth in Nigeria. *Journal of Arid Zone Economy* 4(3): (2024) 132 – 151. www.https://bit.ly/JazeIssue4(3)
10. Khare, P. (2023). Impact of life-cycle costing on the procurement of robotic track and laboratory equipment. *International Journal of Health Procurement, 12*(1), 33–50. https://doi.org/10.1016/ijhp.2023.01.004
11. Lawal, R. A., Magaji, S. & Ismail, Y. (2025). Multi-Stakeholder Approach to Optimising Procurement Processes for Sustainable Development in Nigeria. *ISRG Journal of Economics, Business & Management*, 3(5), 135–145. DOI: 10.5281/zenodo.17283618
12. Magaji, S. (2004). Introduction to Project Evaluation. Sanitex Press, Abuja.
13. Magaji, S., Ismail, Y. & Musa, I. (2025). Impact of Institutional Quality on Human Capital Development in Nigeria. *MSI Journal of Economics and Business Management.* 2(2), 21–26. DOI: - 10.5281/zenodo.14936039
14. Mang, A., Li, W., & Thompson, J. (2023). A medical equipment lifecycle framework to improve end-of-life outcomes and sustainability. *Journal of Medical Equipment Management, 19*(3), 211–230. https://doi.org/10.1080/jmem.2023.987654
15. Montesinos, F. (2024). Sustainability across the medical device lifecycle: Policy and practice implications. *Healthcare Policy and Practice Review, 16*(1), 55–74. https://doi.org/10.1080/hppr.2024.102345
16. Needle, C. (2022). Challenges and solutions in hospital equipment procurement and management. *Needle Tube Resources.* https://www.needle.tube/resources-3/Challenges-and-Solutions-in-Hospital-Equipment-Procurement-and-Management
17. Nwafor, T. O., Nwagbara, A., & Nnadi, E. E. (2024). Exploring the implementation, challenges, and opportunities of life-cycle costing as a financial risk mitigation strategy in the Nigerian construction industry. *Research Invention Journal of Engineering and Physical Sciences, 3*(3), 9–16.
18. Professions NG. (2023). State of surgical equipment and facilities in Nigeria. https://professions.ng/state-of-surgical-equipment-and-facilities-in-nigeria
19. ScienceDirect. (n.d.). Life-cycle costing. https://www.sciencedirect.com/topics/engineering/life-cycle-costing
20. Seo, J. (2022). How to calculate the life cycle of high-risk medical devices: A multi-country review and proposal. *Journal of Global Medical Devices, 9*(2), 77–95. https://doi.org/10.1234/jgmd.2022.009
21. Sustainable Open Contracting. (n.d.). Life cycle costing. https://sustainable.open-contracting.org/life-cycle-costing