An Overview of Whole Life Cost Analysis as Sustainability Tool towards Competitive Bidding in Nigerian Construction Industry

A.C.C. Ezeabasili[1], N.U. Dim[2], B.U. Okoro[3]
[1] The school of Built Environment, Quantity Surveying of Salford, University of Salford, UK. accezeabasili@yahoo.com
[2] The school of Built Environment, Construction Management, University of Salford, UK. nattdims@yahoo.com
[3] Department of Civil Engineering, Nnamdi Azikiwe University, Awka. ugoben@gmail.com

***Abstract*—Majority of bidders in Nigerian construction Industry capitalized on the low cost bidding in order to win the project contract while few bidders centre their bidding on quality. Meanwhile, the whole life cost of the project is being ignored in all the cases. The WLC extend far beyond the acquisition or initial construction cost. The high cost of the bidding exercise which is not refundable in some cases, and cannot be recovered when the bidder loses in the bidding exercise, makes the exercise not sustainable. This work was done by reviewing different documents on Bidding and life costing analysis. This review explored the Bidding efficiency, strategies for selecting projects, and bid for mark-up strategies in Nigerian construction industry. Appropriate performance analysis such as SWOT Analysis and Average bid method were recommended as strategies to achieve a sustainable bidding practice in the emerging Nigerian construction industry.**

Keywords—Bidding, whole life costing, and sustainability.

INTRODUCTION

Flanagan and Norman (1985), Chan et al. (1996) in their researches have suggesting that price differences spring up from systematic variations rather than random variation. Changes in demand, firm capacity level and competitor behavior defines in a concise way the variation in bid over time (Runeson and Skitmore, 1999). The bidders need for work highly correlates with changes in demand and this tends to be high in recession time as the demand decreases. McCaffer and Pettitt's cusum chart (1976) in curve noted that gradual reduction in bids with respect to competitors is usually observed by bidders; this is to increase their chances of winning the contract. The attainment of the contract results in rapid change in subsequent bids by the bidders due to unwillingness to win the job. Research conducted on testing the statistical significance of the bidding trends detected in McCaffer and Pettitt's cusum curve (1976) further reveals that winning bids doesnt generally precede highly competitive bids, and the trend of high or low bids over a period of time is most certainly attributed to the presence of highly uncompetitive bids outliers (Skitmore and Runeson, 2006).

Runeson and Skimore (1999) assumed that behaviors of competing bidders are usually fixed at any time (no allowance for continuity). However, the strategic motivation for alteration in pricing behavior is the long-term survival strategy for a firm to survive especially when demand levels leads to congestion, intensifying competition or changing the needs of customers (Skitmore and Smyth, 2007).

WHOLE LIFE COSTING IN BIDDING

Building Research Establishment (BRE) defined whole life costing as an assessment of the life performance and cost of an asset over its lifetime taken into consideration initial capital costs and future costs, including operation costs, maintenance costs and replacement / disposal costs at the end of its life (not only the capital costs). According to Woodward (1997), the life cycle cost of a building is the sum of all funds spent on building from its conception, design development and construction to the its operation, and demolition of the building. Thus the whole life cycle analysis of any project begins when the acquisition is first considered and end when the building is demolished.

Broadly, life cycle costs are those associated directly with constructing and operating the building; while whole life costs include other costs such as land, income from the building and support costs associated with the activity within the building. The expertise of the construction industry is best placed to deliver life cycle costs, which its clients can then use to calculate whole life costs.

The objectives of the whole life cost analysis in bidding according to Royal Chartered of Surveyor (1983) in Alexandra de Caryalho (2010) are: For effective evaluation of the project which gives the bidder a sense of direction on how to approach the bidding; to consider the impact of all costs rather than only the initial capital cost; to assist in the effective management of the project and to create choice for competing alternatives. The Lifecycle costing (LCC) identify all the future cost and reduces them to the present value by the use of discounting technique through which the economic worth of the project can be assessed. For this objective to be achieved, the following cost elements of LCC should be identified: Initial capital cost (design development and construction cost), life of the asset, the discount rate, operating and maintenance cost, demolition cost, uncertainty and sensitivity analysis (Woodward, 1997).

Whole Lifecycle Analysis Indices and Determination

The forecast life of a project is a major influence on the whole lifecycle assessment. The five determinant of the lifecycle expectancy are the functional life, physical life, the technology life, economic life, and social and legal life (Woodward, 1997). The physical life is the period which the building project is expected to last physically to when refurbishment is physically needed. The functional life is the period over which the need of the asset is anticipated. The technology life is the period until the technical obsolescence detects replacement due to new superior technology alternative. And, the social and legal life is the period until human desire and legal requirement for the asset detect replacement. The essence of lifecycle analysis is to operate the asset at a minimum cost. In other words, estimating the operating and maintenance cost is essential to minimize the whole life cost of the asset. And, to achieve a minimal cost of operating and maintaining the project, it is wise to maximize the cost of design development, and construction of the project as shown in figure 1.

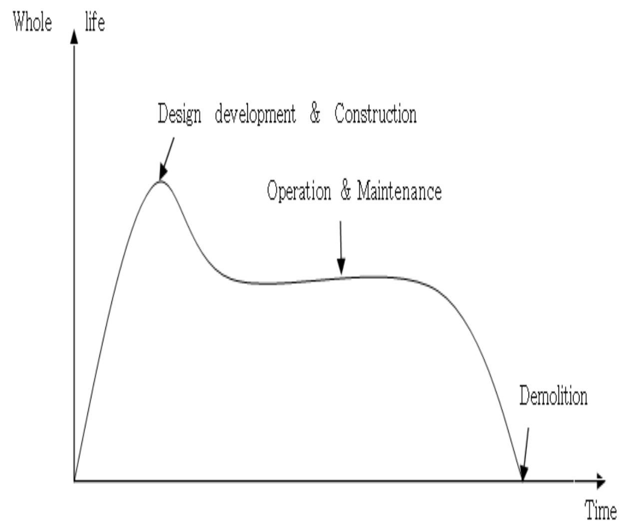

Figure 1: Stages of lifecycle cost

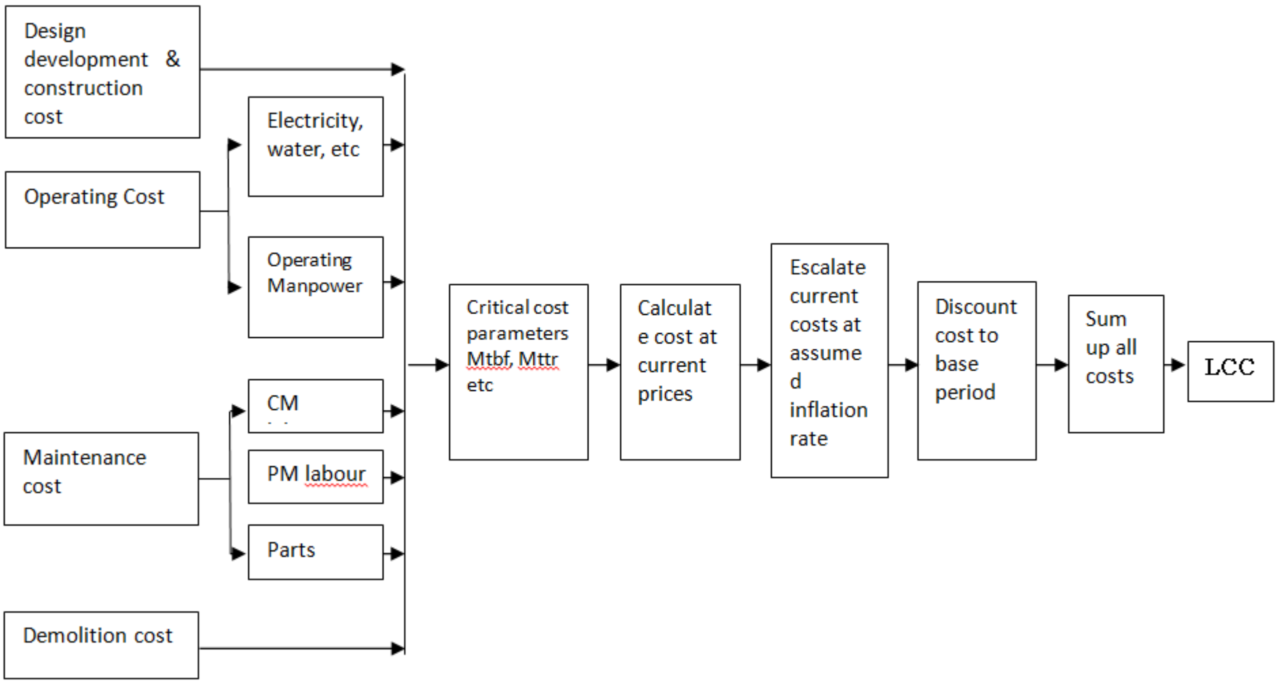

Figure 2: Kaufman's lifecycle costing formulation (Woodward, 1997)

From Figure 2, the CM represents corrective maintenance, PM represent preventive maintenance, Mbtf represents Mean time before failure, and Mttr represents Mean time to repair. Kaufman developed a formulation for the whole lifecycle costing based of the eight steps stated below:

The first step describes the periodic cycle through which a project will go and indicate when the asset will be use and when not. This first step is called the operating profile (OP). The second step is the Utilization factor which indicates the way the asset will be functioning within each mode of the operating profile. The third step is to identify every cost element followed by step four which is to identify the critical cost parameters. The critical cost parameters according to Woodward (1997) are those factors which control the degree of cost incurred during the lifecycle of the asset. The most significant parameters relevant for a project are time period between failure (MTBF), the time period for repair (MTTR), the time period for schedule maintenance, and the energy use rate. Firstly, all costs are calculated at the current rate in step five. After calculating the all cost at the current rate, the current costs are escalated at an assumed appropriate inflation rate in step six. The cash flows which occur in different period are discounted back to the base in step seven to ensure compatibility because money has a time value. Finally, all the cash flows from the design development and construction cost to the discount cost are summed up to obtain and establish the whole Lifecycle cost of a project.

Important Issues Affecting Whole Lifecycle Analysis

Anbola (2014) noted that on every project whole life cost comparisons should be carried out on 5 chosen elements/products and their alternatives. The following considerations as stated were:

- Identify the period of analysis with reasons for choice if less than 60 years is chosen.
- Identify the discount rate to be applied. This should be 3.5% unless project requirements give other discount rates to apply.
- Inflation should be assumed at zero, unless project requirements give other inflation rates to apply.
- Investigate the replacement periods of the chosen product, using generic data from BCIS or manufacturer's data. These costs are to be noted for the relevant years of the project.
- Identify on going recurring costs such as energy costs, maintenance etc.

The five key elements on the project that have significant impact are chosen such as the windows, frame, roof, floor slab, internal walls, external walls. The 5 chosen should have a minimum of these:

- Have high capital costs,
- Are products that may generate energy, waste or water savings?
- Reduced maintenance and running costs.
- New products that is known to the project team.

The Nigerian Construction Industry and Her Capacity Buildings for the Analysis of lifecycle cost analysis

The application of the whole life cycle costs in the Nigerian building industry, though appreciated by professional bodies in the building industry, is limited, if any in practice. Researches in the field have been researching in various aspects of this but curiously there is no known application in the both public and private sector of note. There are few trained manpower in this field and these manpower most of whom are into research who write in journals and conferences to elucidate the value of Whole life costing. In practice the few who appreciate the WLC are actively working to introduce it in both private and public sectors but the problems of existing data or generation of new ones is inhibiting the progress.

Again the Government of Nigeria at the level of policy making has not helped issues as much as there is a lot of brain storming among the professionals. On this, the procurement policy of the government has not taken note of or given any directive as it position. More especially, clients from the private sectors in private public partnership (PPP) projects ought to have been educated on the benefit they would derived from the practice in the final analysis. The initial costs of introducing the whole life costing are always high and client who are mainly uneducated do not see the long run aspects of their construction investments. The present economic downturn would likely affect the introduction or whole life costing because of the difficulty in sourcing of capital that is needed to fund high portfolio projects. On the other hand, few clients are recognizing sustainable principles of re-cycling or using products of decommissioned projects for their new projects. This has reduced the practice of carting away to spoils from products of demolished projects.

Typical Whole life cost plan for a Building and the ease of data collection in Nigeria.

Table 1 shows a plan of a proposed expenditure of a building project over its entire life span. The Net Present Value (NPV) or Annual Equivalent (AE) can be used to show the total information. The capital cost is the estimate of the initial cost, and this is already a present value amount estimate which would include errors of prediction. This will be true for the estimating of costs in use. Also, the maintenance cost would be on annual basis using feedback information from past projects compiled with the current knowledge.

Table 1: Whole life cost plan and relative ease of evaluation (Adapted from Cost study of Building, Ashwork, 2010)

Description Value	Discount Factor	Estimated Cost	Present
Capital cost	Easily evaluated	Easily evaluated	Easily evaluated
Maintenance per Annum	Not Easily evaluated	Easily evaluated	Easily evaluated
Redecoration (intervals)	Not Easily evaluated	Easily evaluated	Easily evaluated
Minor new works	Easily evaluated	Easily evaluated	Easily evaluated
Energy (per Annum) Heating Lighting power	Easily evaluated Easily evaluated Easily evaluated	Easily evaluated Easily evaluated Easily evaluated	Easily evaluated Easily evaluated Easily evaluated
Cleaning (per Annum)	Not Easily evaluated	Not Easily evaluated	Not Easily evaluated
General rates (per Annum)	Subjective	Subjective	Subjective
Insurance (per Annum)	Subjective	Subjective	Subjective

Estate Management (Annum)	Not Easily evaluated	Not Easily evaluated	Not Easily evaluated
Additional tax allowance (per Annum)	Determined by Govt (not Stable)	Determined by Govt-	Determine by Govt.-
Total Net Present Value (NPV)	Calculated	Calculated	Calculated

WHOLE LIFE CYCLE AND SUSTAINABILITY CONSTRUCTION IN NIGERIAN BUILDING PROJECTS

The design, construction, and maintenance of buildings has an impact on the environment and natural resources around it because buildings consume a lot of energy produced and designers should reduce those energy demand. The buildings should have a minimum amount of non-renewable energy in use, produce minimum pollution, and reduces the associated cost involved to a minimum. Also, buildingS should increase the comfort, and health and safety of occupants. The application of sustainable construction on building projects may initially involve a high construction costs. As such, the client should be made to understand that the high cost of the sustainable design analysis and development, engineering, energy modeling, and construction will reduce the whole life cost of the building project as a result of the reduced operational and maintenance cost. etc

Integrated approach to advanced technology like the Building Information Modeling (BIM) has to be utilized to promote the building resource conservation, consider the environmental impacts and waste mitigation, create a healthy and comfortable environment, reduce operation cost and address issues of historical preservation, transportation and infrastructure. The whole life cycle of a building and its components should be compared together with the economic and the environmental impacts and the performances. Engineers and other building professionals may likely understand what infrastructure means but understanding what sustainability implies is another issue entirely. However, there are a number of guidelines and documents that show that many professional societies in Nigerian now have descriptions relating to sustainability in engineering practice and related professions. Arguably, many of us likely have an innate sense of what sustainability should entail, and its characteristics should include: Triple bottom-line thinking that considers social, economic, and environmental issues; balanced leadership that can comprehensively examine multiple objectives and include participating stakeholders; impact evaluations that consider long-term effects rather than just short-term gains or losses. However, these are plausible and often agreed upon elements.

Among others elements required is the operations and maintenance (O&M) costs in which over many decades can amount to more than the initial capital cost. Moreover, O&M costs for a typical building far outweigh its initial construction costs. From an economic sustainability perspective, economic considerations such as these have been in civil engineering practice for some time. However, the same cannot be said for lifecycle assessments (LCA) that consider environmental impacts over a project's life, including its disposal or re-use. It is critical that engineering and related school curriculum increase the emphasis on long term O&M and LCA considerations (Perk et al., 2014).

It is imperative to question regulatory criteria when they indicate unaffordable lifecycle cost solutions and suggest more cost-effective and sustainable options that can still meet the intent of the criteria. For example, water quality trading can be much more cost-effective than building new treatments facilities. Also, focus on the real "need rather than the "wants". The traditional sit bottom-line engineering approach of focus on "tried and true" or "proven" technology can overlook new, emerging technologies alternatives that may, in fact, satisfy the need, meet the objective, and be more cost effective in the long term when indirect and extent triple bottom-line costs (and benefits) are considered. Similarly, the desire to implement state-of-the-art technological solutions lead to extravagant solutions being offered where a more conventional solution would have been perfectly acceptable. For example, construction of a motorized borewell in Nigeria might cost $30,000 per house community, where a extending piped water to same house community can cost $30,000 per house or more.

Many new water treatment plants are designed and built to meets increased demand, despite the fact that most of the treated water capacity is through leakage and waste.

Adopting a simple, understandable evaluation criteria that assimilate triple bottom-line costs and benefits into a single number, ₦ per house serviced, ₦ per m3 of water treated, ₦ per kg of phosphorous removed (from a river), ₦ per km of road length, and ₦ per m2 of building area. These simple benefits-cost criteria are readily understood by decision makers, while allowing for cross-sectional and longitudinal benchmarking and comparisons of sustainable engineering solutions. Furthermore, cost effective alternative can be sustainable in the truest sense; over the long term, the least resources are expended, and impacts are often minimized.

Perks et al. (2014) further noted that over complicated decision making criteria is difficult for the public to understand, and makes it relatively easy to influence environmental assessments to favour preconceived solutions. It is important to seek out anomalies in alternative solutions. For example, five alternative solutions may be presented, and the one chosen may have multiple advantages and only one disadvantages which might cost much more than any other solution considered. Conversely, building a new wastewater treatment plant, with one more advantage in the environmental assessment scoring matrix, could cost 10 times more than simple upgrading an existing lagoon system. Therefore, decision making criteria should not only be fairly weighted through proper stakeholder consultation process, but also minimized for bias. This will engineer for maximum sustainability through utilizing the least resources and to minimize or avoid lifecycle environmental and social impacts.

CONCLUSION

When a project whole life cost analysis is been considered and included by a bidder in a bidding exercise, it will incorporate an accurate estimate of not only the construction cost and mark-up but operating, maintenance, and reselling or disposal/demolition cost which, will go a long way to serve as a good decision tool towards convincing investors in Nigerian construction industry towards the sustainability of projects and gives the bidder an advantage among his follower competitors. On the other hand, it will also increase the sustainability opportunity for the bidder to get continuous profitable jobs, give the bidder an advantage over his competitor as it will catch the attention of the customer.

More so, the information will be useful to the customer especially in a case where the customer's consultant on cost Engineering fails to provide such detail cost analysis. Therefore, this study recommends that bidders should consider a project whole life cost analysis in their bidding exercise to increase their chance of getting the customer's attention and winning the project. Also, conference and workshops are recommended as one of the ways to educate stakeholders about the importance of this concept.

REFERENCES

1. Alexandra de Carvalho, F.R. (2010) Contribution of Life Cycle Cost analysis to design Sustainability in Construction. Instituto Superior Technico, Universidade Tecnica de Lisboa. Pp 3.

2. Anbola A.A. (2014) 'Cost Model', Published Masters Thesis, Construction Logistics and Estimating.

3. Ashwork, A (2010). Cost Studies of Building. "Prentice Hall" 5th Edition.

4. Chan, SM, Runeson, G and Skitmore, M (1996) 'Changes in profit as market conditions change: An historical study of a building firm', Construction Management and Economics, 14(3), 253-264

5. Construction Management and Economics 25: 619-630.

6. Flanagan, R., and Norman, G. (1983). The accuracy and monitoring of quantity surveyors' price forecasting for building work. Construction Management and Economics, 1(2), 157-180.

7. McCaffer, R., and Pettitt, A. N. (1976). Distribution of bids for buildings and roads contracts. Operational Research Quarterly, 835-843.

8. Perks, A., Lovegrove, G., Khan, A., Tam, E., and Brown. D. (2014) Operationalizing Sustainability in Civil Engineering Practice, CSCE 2014 General Conference – May 28-31, CSCE Sustainable Development Committee, University of Windsor.

9. Runeson, G., and Skitmore, M. (1999). Tendering theory revisited. Construction Management & Economics, 17(3), 285-296.

10. Skitmore, M. and Smyth, H. J (2007) "Pricing construction work: a marketing viewpoint."

11. Skitmore, M., and Runeson, G. (2006). Bidding models: testing the stationarity assumption. Construction Management and Economics, 24(8), 791-803.

12. Woodward, D., G. (1997). Lifecycle costing theory information acquisition and application. International journal of project management, 5(6). 335-334.

13. Koafman, Operationalizing Sustainability in Civil Engineering

14. Edwin Tam (2004) Canadian civil Engineer, Journal of Canadian Society of Civil Engineers