



Cost Optimization of Residential Structure by Life Cycle Cost Analysis

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ABSTRACT

It is common that cost is the main criterion at the time of making choices between different systems. With life-cycle cost (LCC) calculations, it is possible to get better overview of the total cost. Life Cycle Cost (LCC) is “the total cost of owning, operating, maintaining, and disposing of a building or a building system” over a period of time. History shows that decisions relating to residential buildings are generally based on estimates of the initial construction cost, with no consideration of operation and maintenance cost occurring during life of building. Continuously rising operation and maintenance cost increases overall life cycle cost. It can be minimized by investing most efficient solution at initial stage. The present study includes analysis of all cost of existing bungalow. Applying LCC analysis on new bungalow by Net present value approach. By extrapolating all cost of new bungalow, analysis is done for Do nothing and energy efficient approach. Comparative analysis was done for suggesting cost effective solution.

Keywords: *Life Cycle Costing, Net Present Value, O & M-Operation and maintenance cost*

I. INTRODUCTION

The National Institute of Standards and Technology (NIST) defines life cycle cost (LCC) as “the total discounted dollar cost of owning, operating, maintaining, and disposing of a building or a building system” over a period of time. Life cycle costing (LCC) is used to evaluate the cost performance of a

building throughout its life cycle, including acquisition, development, operation, management, repair, disposal and decommissioning (Davis Langdon, 2006). Life Cycle Cost usually requires many cost inputs for calculating the costs for different phases of project life cycle. The cost variables are categorized into groups : Acquisition cost – Acquisition cost is the initial cost. It is outlays incurred prior to putting assets or system in service. It includes site cost, temporary work, design/engineering cost, planning cost, construction and earthwork, commissioning costs/fees. Maintenance, operation and management cost- Maintenance, operation and management are necessary for ensuring that building function and operate properly throughout its life cycle. The cost items consider in this phase are Rates, Insurance, Energy cost, Water and sewage cost, facility management and cleaning, security and maintenance.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

Life Cycle Costing (LCC) was originally designed for investment purposes in the U.S. Department of Defense. The importance of LCC for the U.S.

Department of Defense was shown by the fact that the operational costs regarding to weapon systems, where 75% of the total life cycle costs.

Benefit of Life Cycle costing:

1. To determine cost effectiveness^I of mutually exclusive alternative, we need to compute the LCC for each alternative and base case, compare them and choose the alternative with lowest LCC.
2. Because various options will be compared, it also improves the decision making process by means of a more measurable and systematic process.
3. LCC also provides the opportunity to the main-actors on the real estate market to monitor the expenses incurred throughout the life cycle of a real estate building (Woodward, 1997; Ashworth, 1996)
4. Finally, the main motivation to apply the LCC method is to increase the possibility of reducing the life cycle costs of buildings.
5. LCC method will help to get a estimation of the Life Cycle Costs, which will have a positive effect on the risk management of a company.

Scope of Life Cycle Costing:

1. **Engineering** avoids specifying cost effective, redundant equipment needed to accommodate expected costly failures so as to meet capital budgets,
2. **Purchasing** buys lower grade equipment to get favorable purchase price variances,
3. **Project engineering** builds plants with a 6 month view of successfully running the plant only during start-ups rather than the long term view of low cost operation,
4. **Maintenance** defers required corrective/preventive actions to reduce budgets, and thus long term costs increase because of neglect for meeting short term management gains.
5. **Costing discipline**-it is concerned with operating and support cost estimates.
6. **Procurement technique**-it is used as a tool to determine cost per usage.
7. **Acquisition tool**-it is concerned with balancing acquisition and ownership costs. Selecting low cost alternative.
8. **Design trade-off**-it integrates effects of availability, reliability, maintainability, capability, and system effectiveness into x-y charts that are understandable for cost effective screening methods.

III. FINDINGS

The selected case is tested in this work, with the purpose of showing how LCC analysis is useful and for that primary data collection is done by interview of owner, architect and also by structural assessment. Two different Bungalows of different age are studied to know the cost history and varying operation and maintenance cost. After studying analysis of existing Bungalows, it is applied over new Bungalow for Do Nothing and Energy Efficient option.

Data required for calculation of LCC:

- 1) Life of Building =50 years
- 2) Discount Rate (i) =6.25%
- 3) Inflation Rate For fuel/light (e) =5.52%
- 4) Study Period=50 years
- 5) LCC OF building=

[Initial Cost of building +PV (Construction Cost) +PV (Operation Cost) +PV (Maintenance Cost) –PV (Residual/Disposal cost)]

Calculations of Life cycle costing shows that 45 % of total cost is used by operation and maintenance, 37% by construction and 18% by land acquisition. Based on this survey the major pie (45%) of total cost is contributed by O & M cost and in second graph major pie (56%) of O & M is contributed by energy cost.

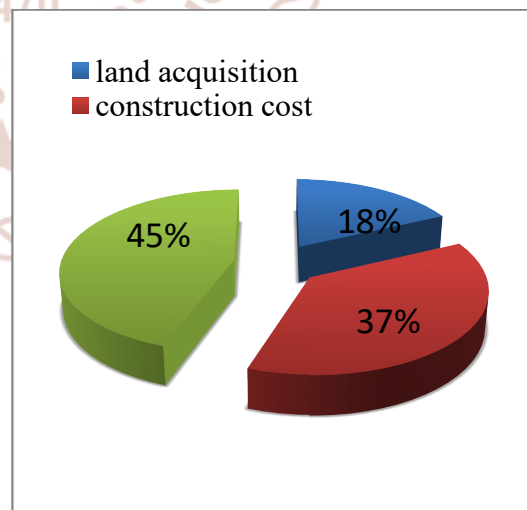


Figure 1. Cost % distribution of LCC

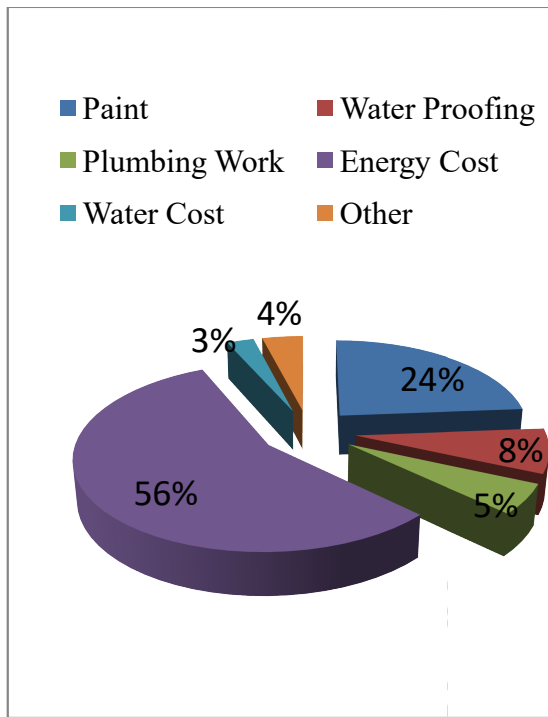


Figure 2. Cost % distribution of O & M Cost

Costs	Discount factor	Present Value at base date
1) Land Acquisition Cost	-	7,50,000/-
2) Construction Cost	0.9433	1557721.69/-
4) Maintenance Cost		
a) Crack repair	0.5583	106095.0/-
b) Paint	0.5583	418796.08/-
c) Plumbing Work(PVC pipe replacement due to leakage)	0.6274	94111.8/-
e) Water proofing	0.5583	139598.69/-
4) Operation Cost		
a) NA Tax	15.761	7880.86/-
b) Property Tax	15.761	31522/-
c) Energy Cost	45.14	993290.94/-
d) Water Cost	15.761	47280/-
f) Cleaning of OHW tank	15.761	15756/-
g) Lumpsum yearly maintenance	15.761	15756/-
5) Residual Cost	0.051215	8963.98/-
Total Life Cycle Cost		4168845.08/-

Table I. Total life cycle cost at base date

Equations used in calculation of LCC :

• **Single Present Value:**

Construction Cost , Crack repair, Paint, Plumbing work, Waterproofing, Residual cost For non-recurring cost

$$SPV = \frac{1}{(1+i)^n}$$

• **Modified Uniform Present Value:**

For recurring having escalation rate

$$UPV^* = \frac{1 - \left\{ \frac{(1+e)}{(1+i)} \right\}^n}{\left\{ \frac{(1+i)}{(1+e)} \right\}^{-1}}$$

Escalation rate for energy=5.52%, discount rate =6.25%

• **Uniform Present Value :**

$$UPV = \frac{(1+i)^n - 1}{i(1+i)^n} \dots\dots\dots$$

For recurring cost like water cost, cleaning cost

IV. DISCUSSION

It is observed from above study that lowest purchase price does not necessarily minimize total cost over the life of asset. LCC of existing Bungalow shows that O & M cost are major contributor to LCC and Detail analysis of O & M cost shows that major pie of O & M cost is contributed by Energy cost. Hence for calculating LCC of newly constructed bungalow it is recommended to give maximum emphasis on energy cost. This can be done by calculating energy cost by Do Nothing and Energy Efficient approach.

V. CONCLUSION

Thus it has been concluded from above study that highly rising energy cost highlight great opportunity for optimizing LCC. Better saving can be achieved over the life of Bungalow by investing cost efficient solution at initial stage only. In the long run LCC with Energy Efficient option still wins over do nothing approach. It is obvious that the benefits will also vary albeit minimally.

Thus, it is clear from above discussion that the use of sustainable formwork materials is of great advantageous for rapidly rising structures providing

benefits over conventional formworks. All the 13 aspects focusing on advantages of sustainable materials over conventional has been described in details thereby providing proper method to be adopted in construction. As automation is on great need & extent now-a-days, it's of great importance to adopt such eco-friendly methods & materials for construction in present Global warming era. This will also reduce the carbon emission in atmosphere thus reducing the chances of addition of pollutants in atmosphere.

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