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# LIFE CYCLE COST ANALYSIS OF A RESIDENTIAL BUILDING

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**Abstract -** *Most of the construction companies calculate the project cost of residential buildings depending only on the initial construction cost which they have to spend till the project is completed with very less or no consideration for costs relating to operation and maintenance throughout the life of the building. Customers in India also do not give much importance to the operation and maintenance of the building throughout its life. Continuously increasing operating, maintenance and energy costs has given importance to the overall savings in the life of a building that can be achieved by investing in cost efficient solutions at the initial stage of building. The purpose of this study is to identify the LCC of a G+5 building using Net Present Value Method (NPV) Method. . The LCC analysis carried out in this work can be used to carry out the LCC analysis of any other buildings in other cities and with the modifications in the input data. The LCC for Residential building by NPV method was found to be Rs. 86,22,64,309.*

***Key Words***: Life Cycle Costing, Life Cycle Cost Analysis, Net Present Value method, Discount Rate, Initial cost, Replacement cost, Operation and maintenance cost, Non Annual Recurring Cost, Salvage value.

## 1. INTRODUCTION

The purpose of a Life cycle cost analysis is to estimate the overall costs of project alternatives and to select the design that ensures the facility will provide the lowest complete cost of ownership along with its quality and function. LCC analysis was first introduced and developed by United States Department of Defense in order to minimize their spending on the purchased equipments. The Life cycle cost analysis should be performed early in the design process while there is still a chance to refine the design to ensure a reduction in life-cycle costs in any construction project cost effectiveness plays a crucial role. The Life cycle cost analysis provides a method of determining entire cost of a structure over its expected life along with operational and maintenance cost. Life cycle cost can be improved by adopting alternative modern techniques without much alteration in the building. Life cycle cost effectiveness can be calculated at various stages of entire span of the building. Moreover this provides decision makers with the financial information necessary for maintaining, improving, and constructing facilities. Financial benefits associated with energy use can also be calculated using Life cycle cost analysis.

### 1.1 Need For Calculating Life Cycle Cost Analysis Of Residential Building

Investment decisions relating to residential buildings have based on initial construction cost, with little or no consideration for costs relating to operation and maintenance throughout the life of the building. The construction and operation of buildings has environmental effects. It is important to reduce them by use of modern energy systems. Construction industry is focusing only on aesthetic design of buildings and its functional goal to fulfill the clients' expectation. Also the clients are looking only at its initial construction cost. Instead of merely looking at its structural cost alone, owners have to broaden their perspective to include entire cost of a structure over its expected life along with operational and maintenance cost.

### 1.2 Application areas of LCCA

1. Long-range planning and budgeting.
2. Controlling an ongoing project.
3. Comparing competing projects Life Cycle Costing Fundamentals.
4. Deciding the replacement of aging equipment.
5. Construction sector.
6. Machineries.
7. Tools.
8. Organic, inorganic consumable and non-consumable products.
9. Comparing logistics concepts.
10. Selecting among competing bidders for a project.

### 1.3 Objectives of the Study

1. To identify various costs involved in Life Cycle Cost Analysis.
2. To study the Net Present Value method
3. To carry out the LCCA of a G+5 Residential Building by Net Present Value method.
4. To study the advantages and disadvantages of NPV method.

## 2. PROBLEM STATEMENT

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## 3. METHODOLOGY

### 3.1 General

LCC is a valuable technique which is used for predicting and assessing the cost performance of the assets. The purpose of LCC is to quantify the life cycle cost for input into a decision making or evaluation process. LCC is being used from 1965 for different purposes such as procurement of equipments health, education and welfare department; assessments of the buildings, military purposes and many more. LCC analysis involves different costs involved in the total life span of an asset such as construction cost, operation and maintenance costs, electricity cost, equipment replacement costs and disposal cost. The elements of LCC are initial capital costs, life of the asset, the discount rate, analysis period (design life, useful life, functional life, physical life, technological life, economic life or social and legal life), operation and maintenance costs, disposal cost, information and feedback. Life cycle cost is applied to calculate costs of whole building its systems and components and materials. In life cycle costing, future costs, such as operation and maintenance costs associated with an item, have to be discounted to their present values before adding them to the item's acquisition or procurement cost. Over the years, many formulas have been developed in the area of economics for converting money from one point of time to another [14]. Following are the steps involved in life cycle costing methodology:

Step-1: Determining the objectives of life cycle cost analysis.
Step-2: Literature review and problem statements.
Step-3: Method of Life cycle cost analysis, Net Present Value.
Step-4: Collection of all necessary data required of a residential building.
Step-5: Applying the data collected to the selected methods.
Step-6: Calculating total life cycle cost.
Step-7: Formulating the life cycle cost analysis results.
Formula for Life Cycle Costing is as below [8]:

**Life Cycle Costing (LCC) = C+R+A+M+E-S**

Where, C= Initial cost.
R = Present value of replacement cost.
A = Present value of annually recurring, operating, maintenance and repair cost.
M = Present value of non-annually recurring operating, maintenance and repair cost.
E = Present value of energy costs.
S = Present resale value or residual value or salvage value.

### 3.2 Net Present Value Method

Net present value is defined as the sum of money that needs to be invested today to meet all future financial requirements as they arise throughout the life of the investment [15]. The net present value (NPV) of a flow of cash is a system proposed by many as the best for evaluating building-related options. Life cycle costing is the sum of all costs involved in the construction, operation, maintenance and the disposal costs throughout its life span. Project costs that occur different points in the life of asset cannot be compared or added directly due to the varying time value of money. NPV method takes into account the time value of money and gives the realistic results. They have to be discounted back to their present value through the appropriate equations. Costs must first be converted into their time equivalent value at the base date before being combined to compute the LCC of a project. This time equivalent value is referred as the present value of the costs. The discount rate is the interest rate used to convert future expenditures to their present value at the base date, taking into account the time value of money and the rate of inflation. Net present value is calculated by adding present values of all years. The system takes into account all the apparent variables acting upon a cash stream .The formula for net present value is as below [15]:

$$\mathbf{NPV} = \sum_{t=0}^{T} \frac{\mathbf{Ct}}{(1+r)^t}$$

Where, NPV = Net present value
Ct = cost in the year t
r = discount rate in decimals
t = time period.

The discount rate is the interest rate used to convert future expenditures to their present value at the base date, taking into account the time value of money and the rate of inflation.
The discount rate is calculated as [8]:-

$$\mathbf{(1+r)} = \frac{\mathbf{(1+interest\ rate)}}{\mathbf{(1+inflation\ rate)}}$$

## 4. DATA COLLECTION

The data is collected of a residential building Yash-laxmi Heights located near Gangapur rd, Nasik. This is a G+5

residential building consisting of total 30 flats. Life of building is considered 80years. Data collected consist of total cost of work, operating and maintenance cost of the building yearly, non annually recurring costs, replacement cost. Total construction cost of the building is taken. Operation and maintenance cost are calculated by converting all the monthly expenditures such as electricity charges, water charges, cleaning staff, watchmen, etc. into yearly expenditure. Non annual recurring cost such as coloring is done after every 10 years. Replacement costs of components like bore well, elevators, electrification and plumbing is calculated depending on its initial construction cost. Bore well, elevators, electrical, plumbing are to be replaced after 10, 20, 20 and 40 years respectively according to Government of India's CPWD General Specification of electrical works. Initial construction cost was used to calculate depreciation and replacement costs.

## 5. DATA ANALYSIS

Life cycle cost of residential building was carried out using Net Present Value (NPV) method. Salvage value is taken 10% of the Total initial construction cost. Discount rate is calculated using interest rate and inflation rate. Interest rate is taken from State Bank of India website and Inflation rate is taken from government of India's ministry of statistics and programme implementation central statistics office. The future operation, maintenance, non annually recurring and replacement costs are assumed to increase by 10% each year. Net present value of operation and maintenance cost is calculated by adding all present values. Similarly NPV of non annually recurring and replacement cost is calculated. Non annual recurring cost such as coloring is calculated at an interval of 10 years. Bore well, elevators, electrical, plumbing are to be replaced after 10, 20, 20 and 40 years respectively and thus their replacement cost is calculated at given intervals respectively. All the calculations are done using MS Office Excel.

## 6. RESULTS AND DISCUSSIONS

The LCC analysis result for NPV method for the residential building in Nasik is shown in the table no.1. The results shows the values obtained for initial cost, replacement cost, operation and maintenance cost, non annually recurring costs and the salvage value for 80 years life span of the building at 3.24% discount rate. Total LCC is obtained by adding all these costs together except for the salvage value which is being subtracted. The LCC for residential building by NPV method is obtained as Rs. 86,22,64,309.

**Table -1:** Life cycle cost of residential building for 80 years at 3.24% discount rate.

| Sr. no | Description | NPV method (cost in Rupees) |
|---|---|---|
| 1 | Initial cost (C) | 3, 32, 40,000 |
| 2 | Replacement cost (R) | 27,13,55,492 |
| 3 | Operation, maintenance cost (A, M and E). | 14,65,17,794 |
| 4 | Non Annual Recurring Cost | 41,44,75,023 |
| 5 | Salvage value (S) | - 33, 24,000 |
| **6.** | **Total Life Cycle Cost (LCC)** | **86,22,64,309** |

Advantage of NPV method is that it takes into account the time value of money and gives the realistic results. The NPV method takes into consideration the cost of capital and the risk inherent in making projections about the future. Hence this method is useful in the proper scheduling and financial management of the future costs and activities of the Residential buildings. Profitability and risk of the projects are given high priority in the NPV method and it also helps in maximizing the assets value. NPV method is difficult to use. NPV method cannot be used to compare projects with different life span.

## 7. CONCLUSIONS

1. Costs involved in LCCA are initial construction cost, operation and maintenance cost, replacement costs, non annually recurring costs.
2. The LCC for residential building by NPV method is obtained as 86,22,64,309.
3. The NPV method is useful for carrying out the LCC of long life span projects. The LCC analysis carried out in this work can be used to carry out the LCC analysis of any other Similar Residential buildings and of other technologies with the modifications in the input data. The LCC analysis can be used by builders and residents to identify beforehand the budgeting needs of the project and raise funds for the same.

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