

Life Cycle Cost Analysis Of Buildings

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Abstract

At the time of taking financial decision in construction projects decision maker tempting to think in the short term. In a high construction projects more importance is to place the up-front costs, with less attention to future cost. In order to improve long term decision making life cycle cost analysis is important. Purpose of life cycle cost analysis is to determine cost of project for any number of years. Many times project engineer consider only initial construction cost, with little or no consideration of operation cost, maintenance cost as well as energy cost throughout the life of the building. Life cycle cost analysis (LCCA) method consider initial cost, operation cost, energy cost, maintenance cost, repair cost and residual value to estimate cost effectively. In this paper various economic evaluation methods to calculate life cycle cost (LCC) of building has been discussed and comparison of these methods has been carried out.

Keywords

- LCC-Life cycle cost, LCCA-Life cycle cost analysis SPP -Simple payback period,DPP- Discounted payback , NPV- Net present value, EAC- Equivalent annual cost, IRR- Internal rate of return, NS- Net saving .

1 INTRODUCTION

Construction industries and architecture are mainly focused on two primary concerns in the creation of buildings. A very first concern is the design of building for the architect. Architect tries to fulfill the client expectation such as design of the building should satisfy client's aesthetic and functional goals. Second concern is the construction of a building for contractors. Contractor focus on the cost of building & how should the building be constructed? Instead of focusing on Cost to design and construction there is need to Consider operation, repair, replacement and disposal cost. Because sometime operations, repair, replacement and disposal cost may be more than the initial cost. Life cycle cost analysis is the method to calculate life cycle cost. Typical LCC analyses are based on: Construction cost, Operational costs including utility costs such as energy and water use, Maintenance costs including all costs of replacement, maintenance and repair, End-of-life costs such as removal, recycling or refurbishment and decommissioning. It 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 the weapon systems, was 75% of the total life cycle costs. The U.S. National Science Foundation organized, together with the U.S. Department of Defense an integral academics and industrial conference. During this conference many methods were drafted to gain an insight economic consideration in the design stage according to the life cycle costs of different weapon systems. Later the LCC method was also applied in the automobile sector and in the engineering sector. LCC is based on an integrated approach with respect to the Flanagan and Jewell an office building will consume more than four times its initial capital cost over a 25 year period

2. Life cycle cost calculation terminology

Categorization of various costs related to construction, operation and maintenance of building are called terminology .Following are the terminologies used while calculating LCC of a building. Mainly seven terminologies are used that terminologies categorized likewise Initial cost, Operation cost, Maintenance cost, Repair costs, Replacement Costs, Residual Value, and Energy Cost.

Initial cost: Initial cost includes land acquisition cost, design cost and construction cost.

Operation Cost: Operational cost includes cost required for annual building utilities and services excluding maintenance and repair cost involved in the operations of facility.

Maintenance cost: Maintenance cost includes cost required for the maintenance of water pump, maintenance of passenger lift, annual roof inspection etc.

Repair costs: Repair cost includes cost required to extend the building life without replacing the system entirely

Replacement costs: Replacement Cost required to Replace-ment of entire component.

Residual Value: Residual value is the value of the building at the end of the study period or at the life cycle period.

Energy costs: Energy cost includes expenses for energy and other utilities.

3. The economic evaluation methods for LCC

There are six economic evaluation methods are available to calculate life cycle cost of the building. Information regarding which method is useful for what calculation, what are the advantages and disadvantages of various methods, where it is usable is given as follows.

Simple payback (SPP) method

Discounted payback (DPP) method

Net present value (NPV) method

Equivalent annual cost (EAC) method

Internal rate of return (IRR) method

4. Comparative study of various economic evaluation methods for LCC

There are many methods such as Simple payback (SPP) method, Discounted payback (DPP) method, Net present value (NPV) method, Equivalent annual cost (EAC) method, Internal rate of return (IRR) method, Net saving (NS) method available for economic evaluation of life cycle cost analysis. The payback period method has some key weakness that are payback method doesn't take into account inflation and the cost of capital, It does not consider the cash flow after the payback period, it ignore time value money [1]. In discounted payback period cash flow used with the discounted cash flow but it also does not consider cash flow after payback period. Net present value considers time value of money [1] and also takes care of all the cash flows till the end of the life. Internal rate of return does not understand economies of scale and ignores dollar value of the project. It cannot differentiate between two projects with same IRR but huge difference between dollar returns. On the other hand, NPV talks in absolute terms and therefore this point are not missed. IRR assumes discounting and reinvestment of cash flows at same rate. If the IRR of a very good project is say 35%, it is practically not possible to invest money at this rate in the market. Whereas, NPV assumes a rate of borrowing as well as lending near to the market rates and not absolutely impractical. IRR enters the problem of multiple IRR when we have more than one negative net cash flow and the equation is then satisfied with two values therefore have multiple IRRs. Such a problem does not exist with NPV. NPV is measured in terms of currency whereas IRR is measured in terms of expected percentage return. From a comparison of NPV and IRR, it can be seen that NPV is actually a better measure than IRR, especially, in long term projects, not only because NPV considers different discount rates but also takes into account the cost of capital. Equivalent annual cost gives an average number. It does not indicate the actual cost during each year of the LCC. Net saving can be used if the investment generates an income [1]. Therefore most LCC model utilize the NPV method. But NPV Should not be usable if the alternatives have different life length.

5. Formula to calculate LCC

Net present value method is preferred for calculation of future costs based on the present data collected. Following formula 8. used for LCC calculations.

$$NPV = C + R - S + A + M + E \dots \dots \dots [1]$$

C = investment costs

R = replacement costs

S = the resale value at the end of study period

A = annually recurring operating, maintenance and repair costs (except energy costs)

M = non-annually recurring operating, maintenance and repair cost (except energy costs)

E = energy costs

The original amount is increased on yearly basis and is discounted proportionally throughout the building life cycle. For Energy costs which can be reasonably estimated in today's

costs. Applying an escalation rate (e) to energy costs on a yearly basis over the life cycle and discounting (i) the costs will provide you with a cumulative PV costs.

$$Present\ value\ (PV) = Ct / (1 + r)^t \dots \dots [1]$$

Where, Ct – Cost in the year t

r – Discount rate is calculated as follows

$$(1 + r) = (1 + interest\ rate) / (1 + inflation\ rate)$$

6. Conclusion:

In a construction projects more importance is to place the up-front costs, with less attention to future cost. In order to improve long term decision making in construction sector life cycle cost analysis is very important. LCCA have highlighted the opportunity for overall saving in the life of building that can be achieved by investing in more cost efficient solutions initially. LCCA provide future impact of decision which has been taken at the initial stage. Cost saving can be achieved by comparing alternative options. Lowest life cycle cost alternative will be the best alternative. Comparative study of various methods of LCCA shows that NPV method is more appropriate.

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