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LIFE CYCLE COSTING & ANALYSIS WITH SPECIAL REFERENCE TO HYDROPOWER PROJECTS - A COST MANAGEMENT TOOL FOR ECONOMIC ASSESSMENT

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ABSTRACT

Life-cycle cost analysis (LCCA) *is a tool to determine the most cost-effective option among different competing alternatives to purchase, own, operate, maintain and, finally, dispose-of, an object or process, when each is equally appropriate to be implemented on technical grounds. For example, for a highway pavement, in addition to the initial construction cost, LCCA takes into account all the user costs, (e.g., reduced capacity at work zones), and agency costs related to future activities, including future periodic maintenance and rehabilitation. All the costs are usually discounted and total to a present-day value known as net present value (NPV). This example can be generalized on any type of material, product or system. In order to perform a LCCA* ***scoping*** *is critical - what aspects are to be included and what not? If the scope becomes too large, the tool may become impractical to use and of limited ability to help in decision-making and consideration of alternatives; if the scope is too small, then the results may be skewed by the choice of factors considered such that the output becomes unreliable or partisan.*

The paper involves the assessment of the various dimensions and scope of Life cycle cost analysis.

Key Words: cost effective, user costs, agency costs, net present value

Introduction:

In the field of modern production contexts, the complexity of processes combined with an increasingly dynamic competitive environment has created, in business management, the need to monitor and analyze, in terms of generation costs, not only the internal production phase but all stages both upstream and downstream in order to minimize the total cost of the product throughout the entire life cycle. To help building and facility managers make sound decisions, the US Federal Energy Management Program (FEMP) provides guidance and resources on applying LCCA that permits the cost-effectiveness of energy and water efficiency investments to be evaluated (see NIST Handbook 135). This document includes an introduction to LCCA.

The term **Life-cycle cost analysis (LCCA)** implies that environmental costs are not included, whereas the similar Whole-Life Costing, or just Life Cycle Analysis (LCA), generally has a broader scope, including environmental costs.

Life-Cycle Costs are all the costs associated with the product for its entire life cycle. Product life cycle costing traces costs and revenues of each product over several calendar periods throughout their entire life cycle including those in different stages of the product life cycle viz., Development phase -R&D cost/Design cost etc.

Life Cycle Costing (LCC) is an important economic analysis used in the selection of alternatives that impact both pending and future costs. It compares initial investment options and identifies the least cost alternatives for a target period.

Essentially **whole life costing (WLC**) is a means of comparing options and their associated cost and income streams over a period of time. Costs to be taken into account include both initial capital or procurement costs, opportunity costs and future costs

Life-cycle cost analysis (LCCA) is a tool to determine the most cost-effective option among different competing alternatives to purchase, own, operate, maintain and, finally, dispose of an object or process, when each is equally appropriate to be implemented on technical grounds.

An estimate of all expenses and revenues a company incurs and derives from a product, t**he life cycle budget,** includes all expenses from research and development, marketing, customer services and so forth. It also includes revenues from sales, royalties and other sources.

Life-cycle assessment (**LCA)**, also known as life-cycle analysis, eco-balance, and cradle-to-grave analysis - is a technique to assess environmental impacts associated with all the stages of a product's life from raw material extraction through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling. Designers use this process to help critique their products. LCAs can help avoid a narrow outlook on environmental concerns by:

- Compiling an inventory of relevant energy and material inputs and environmental releases;
- Evaluating the potential impacts associated with identified inputs and releases;
- Interpreting the results to help make a more informed decision.

Introduction phase – Promotional cost/Capacity costs.
Growth phase/Maturity – Manufacturing cost/Distribution costs/Product support cost.
Decline/Replacement phase – Plants reused/sold/scrapped/related costs.
Manufacturers would base life cycle costing expense allocations on an expected number of units to be sold over the product’s life. Each period’s internal income statement using life cycle costing would show revenues on a life-to-date basis along-with total cost of goods sold, total R and D project costs and total distribution and other marketing costs.

Benefits:

The following are the benefits of product life cycle costing:

(i) It results in timely action to generate revenue or to lower costs that otherwise might never be considered.

(ii) It ensures better decision from a more accurate and realistic assessment of revenues and costs, at-least within a particular life cycle stage.

(iii) It promotes long-term rewarding.

(iv) It provides an overall framework for considering total incremental costs over the life span of the product.

The approach of life-cycle cost analysis was used primarily as a tool to support investment decisions and complex projects in the field of defense, transportation, the construction sector and other applications where cost constitutes the strategic analysis of cost components of a project throughout its useful life. The analysis methodology of Life Cycle Costing (LCC) concerns the estimate of the cost in monetary terms, originated in all phases of the life of a work, i.e. construction, operation, maintenance and eventual disposal/recovery. The aim is to minimize the combined costs associated with each phase of the lifecycle, appropriately discounted, thus providing economic benefits to both the producer and the end user. Life Cycle Costing is an analytical tool and method which belongs to the set of lifecycle approach. Traditionally, LCC was used to support purchasing decisions of products or capital equipment involving a large outlay of financial resources. In the definition provided by Rebitzer & Hunkeler (2005) LCC incorporates all costs, both internal and external, associated with the life cycle of a product, and are directly related to one or more actors in the supply chain.

In recent years, the spread of lifecycle thinking within business planning and management have led to an evolution of LCC methodology by extending the scope of integrated analysis of the three pillars comprising sustainable development - economic, environmental and social – in a financial representation.

LIFE-CYCLE COSTING (LCC):

Life cycle costing is a technique used to estimate the total cost of ownership. It is a system that tracks and accumulates the actual costs and revenues attributable to cost object from its invention to its abandonment. It allows comparative cost assessments to be made over a specific period of time, taking into account relevant economic factors both in terms of initial capital costs and future operational and asset replacement cost. Life-cycle costing is also known as ***total cost of ownership (TCO).***

The process of identifying and documenting all the costs involved over the life of an asset is known as life-cycle costing (LCC). The life-cycle costing process can be as simple as a table of expected annual costs, or as complex as a computerized model that allows for the creation of scenarios based on assumptions about future cost drivers.

Typical areas of expenditure used in calculating the LCC include:

- Planning/design
- Construction and acquisition
- Operations/maintenance
- Renewal and rehabilitation
- Depreciation and cost of finance
- Replacement or disposal

LCC analysis is used to assess corrosion management alternatives. The current cost of corrosion is calculated by LCC analysis and characterized by the annualized value. The cost of corrosion is defined as the corrosion fraction of design, manufacturing, operation and maintenance, technology development and asset value loss.

For example, the LCC of a structure is defined as the cost that includes all cash expenditures to the end of the structure's life, including construction cost, the cost of maintenance, and the cost of outages. The design with the lowest LCC provides the service at the lowest cost. Similarly, with highway bridges, the optimized contribution of each of the contributing components is calculated through LCC analysis, and characterized by the annualized value. The selection of alternative approaches to controlling the cost of corrosion is therefore based on annualized values of initial or capital costs as well as the maintenance over the life of the structure and its replacement.

Effects of Life-Cycle Costing:

Life cycle costing helps companies to be aware of where their products are in their life cycles, because in addition to the sales effects, the life-cycle stage may have a tremendous impact on costs and profits. The life-cycle impact on each of these items is shown hereunder.

Stage	Costs	Approach to Costing	Sales	Profits
Development	No production costs, but R&D costs very high	Target costing	None	None; large loss on product due to expensing of R&D costs
Introduction	Production cost per unit; probably engineering change costs; high advertising cost	Kaizen costing	Very low unit sales; selling price may be high (for early profits) or low (for gaining market share)	Typically losses are incurred partially due to expensing of advertising
Growth	Production cost per unit decreases (due to learning curve and spreading fixed overhead over many units)	Kaizen costing	Rising unit sales; selling price is adjusted to meet competition	High
Maturity	Production cost per unit stable; costs of increasing product mix begin to rise	Standard costing	Peak unit sales; reduced selling price	Falling
Decline	Production cost per unit increases (due to fixed overhead being spread over a lower volume)	Standard costing	Falling unit sales; selling price may be increased in an attempt to raise profits or lowered in an attempt to raise volume	May return to losses

Effects of Product Life Cycles on Costs, Sales, and Profits

Source: Article by Rohit Agarwal:http://www.yourarticlelibrary.com/accounting/costing/life-cycle-costing-meaning-benefits-and-effects.

BUSINESS LIFE CYCLE COSTING

The issue of life cycle costing arrives in the context of at least two aspects: one related to the development of new products, the other in the evaluation of strategic investments (Ciroth,2003). The first refers to the application of Life Cycle Costing to identify measure and evaluate the costs associated with the entire lifecycle of a new product, especially in the case of complex and durable products. The second concerns the application of LCC as a tool for comparative analysis of long-term investment projects and in managing the cost of a new product. The application of LCC in the management of the product can be seen from two distinct perspectives.

a) From the economic perspective of a producer, to support management in planning and managing the product throughout its life cycle;
b) From the economic perspective of a customer, or as an aid in the purchasing stage aimed at determining the total cost for the entire life cycle.

The traditional cost accounting systems tend to focus on the production phase, underestimating the importance of cost information relating to upstream and downstream stages. An integrated view of the different phases of the life-cycle, however, show that the maximization of value added does not depend strictly on cost minimization or revenue maximization at each stage. Following the product throughout its life cycle ensures a useful flow of information to all business functions regarding the elements that determine the success of a product, allowing them to react promptly and effectively to resolve any weaknesses. From this perspective, Life Cycle Costing moves from a mere trend costing instrument to assuming a key role in the support strategies and decisions of business management.

LIFE CYCLE COST ANALYSIS FOR HYDROPOWER PROJECTS

Life cycle cost is a key economic figure resulting from condensing an almost overwhelmingly large quantity of data (Pelzeter et al, 2007). The accuracy and sensitivity of these data can be difficult to analyze its reasonability for life cycle costs assessment.

For hydropower projects, there is a master plan to develop these projects in almost every country. However, because of the available budgets, the projects are needed to be ranked in order to decide which projects are necessary, economical and beneficial more than others. Life cycle cost analysis is one of the useful ways in decision making process and long term planning of the project. So, different projects are needed to compare their life cycle costs and incomes. Because of the various factors that can affect hydropower projects, the uncertainty and the risks are high and difficult to predict.

OBJECTIVES OF THIS STUDY:

a) Compare the life cycle costs and net present values of hydropower projects/plants with ***different types*** of turbine; and

b) Identify the ***major cost contributors*** in life cycle cost of each project.

METHODOLOGY ADOPTED:

In this research, life cycle cost analysis of hydropower projects installed with different types of turbine are conducted on the costs incurred in the hydropower plants to determine the most beneficial technology in terms of cost effectiveness. The hydropower plants for this research are selected among the hydropower plants in the country which are operating currently. To conduct the analysis, all accessible cost data are collected and the researcher followed the cost categories of responsible agencies. All the costs incurred in the selected hydropower plants that can be accessed are considered and then converted into the same period to analyze. The costs data are converted in the same unit (Thousand INR per year) at the end of each year within the analysis period.

Moreover, the data of energy generated from each selected hydropower plant is collected and the income of the power plant is calculated each year using the average energy sales price. The income obtained from the energy generation is considered as one of the parameters in life cycle cost analysis for wider perspective to determine the outcome. The net present values of the hydropower plants are arrived at from the costs and incomes incurred each operation year in the hydropower plants. The analysis's results are converted into cost per capacity and cost per energy, as the capacity of the hydropower plants can affect the results of the analysis.

Among factors influencing the selection of the turbine types of hydropower plants, the result of life cycle cost analysis can be just one of those factors. A final decision may include a number of additional factors outside the LCCA process, such as availability of funding, capability to perform the required construction, expertise and experiences with a particular turbine type and so on.

1. Comparison of Life Cycle Costs of Hydropower Plants

As the capacities of the hydropower plants that can get enough data to conduct analysis are different, the analysis is performed to get the values for unit capacity and unit energy generated for each hydropower plants.

Based on the data analysis for three types of hydropower plants with three different types of turbine, the Francis turbine power plant is more cost-effective than other two types of power plants with respect to the life cycle cost per installed capacity, life cycle cost per energy, net present value per installed capacity and net present value per energy. The Pelton turbine hydropower plant and Kaplan turbine hydropower plant stand next in decreasing order with respect to the life cycle costs per installed capacity, life cycle costs per energy generated and net present values per capacity and energy generated. Thus Pelton turbine plant has the highest values in all factors.

2. Major Cost Contributors in Hydropower Plants

The present values of each cost categories involved in total costs of hydropower plants for each year are calculated to find out the contributors and their ratios in the life cycle costs. The researcher follows the responsible agencies in categorization the costs incurred in the hydropower plants.

In every plant, the life cycle costs spent for civil structures are the largest in the life cycle costs for the whole plants, in other words, life cycle costs of civil structures are major cost contributors in whole life cycle costs of hydropower plants. However, taking into account, only the operation and maintenance costs, the costs incurred for the electromechanical equipment are larger than for the civil structures.

In terms of costs per capacity and energy generated, for each cost category, the hydropower plants can be arranged as Kaplan, Pelton and Francis turbine hydropower plant in decreasing order.

According to the results of the analysis, Francis turbine power plant has the least cost per energy generated in all cost categories so Francis turbine is the most favorable among hydropower plants with different types of turbine.

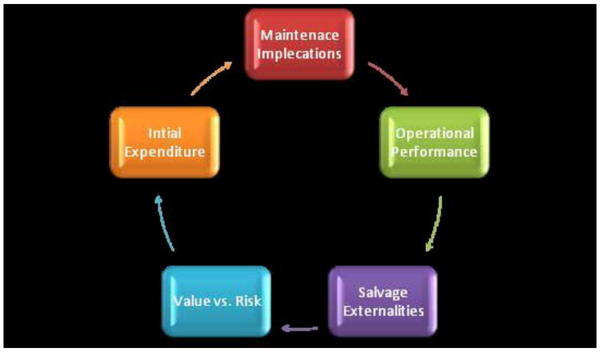
Thus, life cycle costs of civil structures in the analysis period are the major costs contributors in all types of plants while the operation and maintenance costs of the electromechanical equipment are major cost contributors among the total operation and maintenance costs of hydropower plants

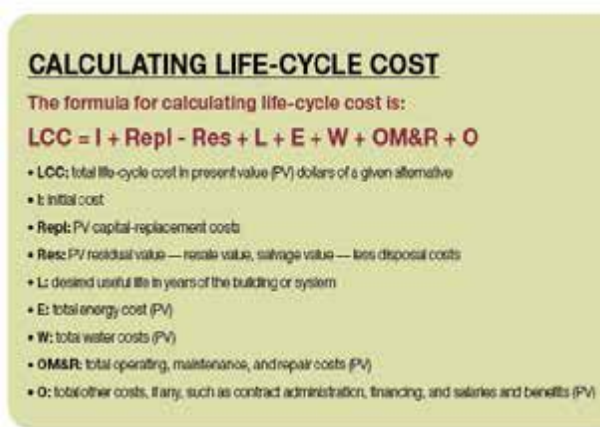
SUMMARY

The hydropower projects are needed relatively large amount of investment relative to most of the other projects in construction industry. Thus, the decision making on selecting the technologies using in the hydropower plants are needed to be analyzed well because of the costs incurred in the whole life of the plant come from the decisions made before starting construction and operation of the plant. Life cycle cost analysis is worth to be conducted as it can give the results not only on the initial costs but also on the costs in the whole life of the studied assets.

In this study, the objective is set to conduct the life cycle cost analysis for the hydropower plants which have installed different types of turbines. The life cycle cost analysis for each type of plant is carried out and the results are shown as per capacity and per energy generated of the plant. The main components of the inputs, which are historical data from hydropower plants, are gathered from the representative agencies. The comparisons of the results of the analysis are performed to select the most cost-effective technology for the hydropower plants in long term basis.

As the results of the analysis, it is found that Francis turbine hydropower plant is more cost effective over than other types.





Source: K.N.Hariharaprasad, Ravikant Kutchibhotla, Life cycle costing – A potential application for making of ships & submarines, Management Accountant March 2017

CHALLENGES IN THE APPLICATION OF LCC

The Strategic Life-cycle costing is very much needed to link the cost data, update and to maintain in entire life-cycle of the turbines continuously till the turbine is decommissioned. And this Cost strategy is useful for management in decision making in replacement of stores and spare which are already used in previous turbines. However, the LCC method implementation is a very challenging task due to there is a lot of gap in the application of Strategic cost management principles. Further, there is a difference between the costing system and methods laid down in their Cost Accounting Instructions manual as there is no uniform costing system/ method in different turbine sites.

HOW TO FACE THE CHALLENGES OF LIFE-CYCLE COSTING (LCC)

As per the learning experience and today's technology and software techniques/ERP solutions will provide the uniform platform for implementation of LCC successfully in every yard. So, that the Costing data of the turbines can be maintained centrally and it can be shared whenever the sites undertake renovations. The following steps should provide the better solution for successful LCC implementation for the R&M of Turbine sites.

a) Replacement of Accrual System of Accounting in place of Cash based accounting system.
b) Establishment of Uniform Costing System in all turbine sites.
c) Utilization of ERP platform for LCC.

d) Cost Data sharing and Cost data linking for all turbines through uniform software.
e) Establishment of network sharing trough Local Area Network (LAN).

EFFICIENCY MEASUREMENT THROUGH APPLYING OF LIFE-CYCLE COSTING (LCC)

Every product has some life. As per the marketing strategy every product having various stages in the entire life of the product and it categorized into

i) Introduction
ii) Growth
iii) Maturity
iv) Decline
v) Obsolescence.

The management should analyze the benefits received and cash-flow received in each stage of product life and it has to match with the expenditure incurred/ cash outflow during the life of the product. So, the cost-benefit, matching of revenue and expenditure is possible ***throughout the life of the product***. Based on the product cash outflows and inflows of each stage in life-cycle of the product is analyzed and the future cash flows discounted as per time value of money concept. This process provides better information about product efficiency during the life-cycle. Thus management can measure the efficiency at each stage of product and they can take a decision in respect of replacement, addition, withdrawn of the product from the main business line of the firm.

CONCLUSION

LCC is the new Strategic Management tool. It provides information for better management and planning of financial recourses to the firm. It is a tool for measuring the efficiency of product service of enterprise. Applying of LCC for each product and service gives fruitful results to the management when they developed the strong accounting system in the yards as well as uniform costing system existed. Further, this costing system should integrate with suitable ERP solution and develop the management information system accordingly. Cost saving through Life Cycle

Costing (LCC) creates Oxygen for new projects and best planning for utilization of financial resources for growth and its sustainable development.

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