The history of the life cycle costing accounting essay

[Business](), [Accounting]()

Capital goods are machines or merchandises that are used by makers to bring forth their end-products or by service organisations to present their services. E. g. power generators, medical equipment used by infirmaries to name and handle patients, trains used by a service organisation such as Virgin Trains to transport clients to their finishs. Capital goods are one of the most of import parts of a company or organisation 's assets. They can be used for their useable life to bring forth the merchandises or services for the clients and increase the value. It is the involvement of both the manufacturer/supplier and customer/user to hold a full apprehension of the capital good life rhythm and its associated costs.

It is widely believed that there are several life rhythm theoretical accounts in industry to see and most of them are instead similar. Fig. 2. 1 shows one general life rhythm theoretical account:

Fig. 2. 1 A General Life Cycle Model (Source: hypertext transfer protocol: //www. ugs. com/)

Phase 1 Conceive: The life rhythm starts with the definition of the capital good based on clients ' demands.

Phase 2 Design: This stage consists of elaborate design and development of the capital good, prototype testing, pilot release and full merchandise launch. It can besides affect redesign and betterment to bing capital good.

Phase 3 Realize: Once the design of the capital good is complete the method of fabrication is defined.

Phase 4 Service: The concluding stage of the life rhythm involves pull offing of in service information, supplying clients and service applied scientists with support information for fix and care. Finally, there is an end-of-life to the capital good. It needs to be considered whether it is disposal or devastation of stuff.

One of the most singular things about life rhythm is that life rhythm procedure is iterative (Fig. 2. 2) . It is ever possible that something does n't work good in any stage sufficiency to endorse up into a anterior stage.

Fig. 2. 2 The loop feature of life rhythm procedure (Beginning: hypertext transfer protocol: //www. ugs. com/)

Another life rhythm theoretical account is developed by Kumar, et Al. (2000) , which consists of 5 stages (Fig. 2. 3) . In the first stage, demands and demands are defined based on feedback from the clients and cognition of proficient possibilities. From the specifications of the capital good major proficient parametric quantities can be defined. Following, the system is wholly designed. After that, multiple units of the system are produced. Then, in the development stage, the capital good/system is used, by and large for extended periods (10-40 old ages) . Finally, the capital good/system is disposed of.

Fig. 2. 3 Life rhythm of a capital good (Kumar, et al. , 2000)

To find the costs associated with the different stages, Life Cycle Costing (LCC) analysis can be a really utile tool.

2. 2 Life Cycle Costing

LCC analysis was foremost introduced and developed by the U. S. Department of Defense in order to minimise the disbursals of their purchased equipment. Nowadays the construct is widely used in both private and public sectors every bit good as in different capital goods industries. In Fig. 2. 4 a typical illustration is given on the costs distribution associated with the different stages of the capital good life rhythm.

Fig. 2. 4 Costs distribution of the capital good life rhythm

To be brief, Life Cycle Costing (LCC) is a methodological analysis for measuring assets that takes into consideration all costs originating from having, runing, keeping, and disposing of the plus (Fuller and Peterson, 1996) . It is the entire discounted cost of acquisition, operation, care and disposal of an plus or system over a fixed period of clip. The elements of cost will be added together to give the entire cost for each point and a expansive sum for the plus through its life clip on a common footing for the period of involvement. LCC analysis enables determinations on acquisition, care, renovation or disposal of the plus to be made in the visible radiation of full cost deductions. Following are two decompositions of costs from different positions.

From the position of clients, they are most interested in the Entire Cost of Ownership (TCO) . The Entire Cost of Ownership (TCO) is the summing up of the cost of geting and having or change overing an point of stuff, piece of equipment, or service and post-ownership cost, including the disposal of risky and other fabrication waste. It besides includes the cost of lost gross as a consequence of downtime or break of service or stop merchandise. Therefore, under the traditional contract (without the performance-based logistics or power by the hr contract) :

TCO = C acquisition + C care + C downtime + C disposal (2. 1)

Acquisition costs: It is the costs during the first three stages of the capital good life rhythm (Fig. 2. 3) , viz. , the initial cost incurred prior to seting the system into service which in many instances is high. It reflected in the gross revenues monetary value for new systems.

The remainder of the TCO occurs after the purchase stage. Multiple types of costs arise during the development stage, with care and downtime accounting for the largest proportion. Care costs consist of all the resources needed for care, which may be executed by the client or by the maker or a 3rd party. In any instance, the points that have to be paid for include trim parts, service/maintenance applied scientists, substructure and direction. Downtime costs may dwell of direct costs, such as those caused by a decrease in the end product of a mill, and indirect costs, such as those caused by loss of repute and resulting loss of future grosss.

Finally, in the disposal stage, there will be disposal costs. Disposal cost is the cost or addition of acquiring rid of assets after usage. These may be important if systems contain environmentally unfriendly stuffs. In many instances, the disposal costs are low. While in some instances, systems or parts of systems may be refurbished and can be reused, so that disposal may even take to gross alternatively of cost.

To give an feeling of how high the costs of a capital good may be after purchase, Fig. 2. 5 shows how the TCO of an engineer-to-order system is divided over the acquisition, care and downtime costs (A-ner et al. , 2007) .

Fig. 2. 5 the TCO of an engineer-to-order system

The consequences showed that the sum of down clip costs can account up to 48 % of entire LCC while care cost history for 27 % . For other systems, we may acquire different Numberss, but by and large the tendency is the same: the acquisition costs history for merely a fraction of the TCO. The care and downtime costs accounted for a important proportion. When the clients buy a new system, they are implicitly doing farther investings that are 2-4 times every bit great as the acquisition costs. Therefore, it is of involvement of both original equipment makers (OEM) and their clients to minimise the TCO.

Another decomposition of costs is given by El-Haram and Horner (2003) . Harmonizing to their survey, Life rhythm costing is composed of entire acquisition cost, entire installation direction (operation and support) costs, and entire disposal cost:

CT = C acquisition + C installation direction + C disposal (2. 2)

Facility Management Costs: Under LCC analysis, installation direction (operation and care) costs are future disbursals which are similar to the care and downtime costs. Facility direction costs may be two to three times higher than acquisition costs. Therefore, there is a demand to plan undertakings that minimizes installation direction costs.

2. 3 The Life Cycle Costing Process

Life Cycle Costing is a six-staged procedure as show in Fig. 2. 6:

Fig. 2. 6 Life Cycle Costing procedure (Life Cycle Costing guideline, 2004)

Phase 1 Plan LCC analysis

The Life Cycle Costing procedure begins with the development of a program, which addresses the intent and range of the analysis. The program should:

Specify the analysis aims in footings of public presentation required to help direction determinations.

Describe the range of the analysis sing the life-time of the capital goods/assets, the operatingenvironmentand the care support resources to be employed etc.

Identify any implicit in conditions, premises, restrictions and restraints (such as minimal plus public presentation, handiness demands or maximal capital cost restrictions) that might curtail the scope of acceptable options to be evaluated.

Supply an estimation of resources required and a coverage agenda for the analysis to guarantee that the LCC consequences will be available to back up the decision-making procedure.

The program should be documented at the beginning of the Life Cycle Costing procedure to supply a focal point for the remainder of the work. Thus the customers/users can reexamine the program to guarantee their demands have been right interpreted and clearly addressed.

Phase 2 Select/develop LCC theoretical account

Phase 2 is the choice or development of a LCC theoretical account that satisfies the aims of the analysis.

LCC theoretical account contains footings and factors which enable appraisal of all relevant constituent costs. Before choosing a theoretical account, the intent of the analysis and the information it requires should be identified. The theoretical account should besides be reviewed with regard to the pertinence of all cost elements, empirical relationships, invariables and variables.

A figure of available theoretical accounts can be used for LCC analysis. And in some instances it is appropriate to develop a specific theoretical account. In either instance, the LCC theoretical account should:

Construct a cost dislocation construction (CBS) that identifies all relevant cost classs in all appropriate life rhythm stages. Cost classs should go on to be broken down until a cost can be readily estimated for each person cost component.

Identify the cost elements that wo n't hold important impacts on the overall LCC of the capital goods/assets. These elements may be eliminated from farther consideration.

Make appropriate premises which should be documented to steer and back up the subsequent stages of the analysis procedure.

Choose a method for gauging the cost associated with each cost component to be included in the theoretical account.

iˆ Determine the information required to develop the estimations and place beginnings for the informations.

Identify uncertainnesss that are likely to be associated with the appraisal of the cost elements.

Integrate the single cost elements into a incorporate LCC theoretical account, which provides the LCC consequences required to run into the analysis aims.

Phase 3 Apply LCC theoretical account

Application of the LCC Model involves the undermentioned stairss:

Obtain informations and develop cost estimations and their timing for all the basic cost elements in the LCC theoretical account.

Identify cost drivers by analyzing LCC theoretical account inputs and end products to find the cost elements that have the most important impact on the LCC of the capital goods/assets.

Validate the LCC theoretical account with available historical informations if possible.

Summarize and categorise the LCC theoretical account outputs harmonizing to the logical groupings (e. g. fixed or variable costs, acquisition or ownership costs, direct or indirect costs) .

Conduct sensitiveness analyses to analyze the impact of fluctuations to premises and cost component uncertainnesss on LCC theoretical account consequences. Particular attending should be focused on cost drivers, premises related to plus use and different price reduction rates.

Review LCC outputs against the aims defined in the analysis program phase to guarantee that all ends have been fulfilled and that sufficient information has been provided to back up the determination. If the aims are non met, extra ratings and alterations to the LCC theoretical account may be required.

Phase 4 Document and reexamine LCC consequences

The consequences of the LCC analysis (including all premises) should be documented to guarantee that the consequences can be verified and readily replicated by another analyst if necessary and let the customers/users to clearly understand both the end products and the deductions of the analysis along with the restrictions and uncertainnesss associated with the consequences. Besides, a formal reappraisal of the analysis procedure may be required to corroborate the unity and truth of the consequences, decisions and recommendations.

The study should incorporate the undermentioned basic contents:

Executive Summary: a brief outline of the aims, consequences, decisions and recommendations of the analysis.

Purpose and Scope: a statement of the analysis aim, plus description including a definition of intended plus usage environment, operating and support scenarios, premises, restraints.

LCC Model Description: a sum-up of the LCC theoretical account, including relevant premises, the LCC cost elements and breakdown construction along with the methods of appraisal and integrating.

LCC Model Application: a presentation of the LCC theoretical account consequences including the designation of cost drivers, the consequences of sensitiveness analyses and the end product from any other related analyses.

Discussion: treatment and reading of the consequences including designation of uncertainnesss or other issues which will steer determination shapers and users in understanding and utilizing the consequences.

Decisions and Recommendations: a presentation of decisions related to the aims of the analysis and a list of recommendations along with designation of any demand for farther work or alteration of the analysis.

Phase 5 Prepare Life Cycle Costing Analysis

The Life Cycle Costing Analysis is basically a tool, which can be used to command and pull off the on-going costs of the capital goods/assets. It is based on the LCC Model which was developed and applied during the old phases with one of import difference: it uses informations on nominal costs.

The readying of the Life Cycle Costing Analysis involves reappraisal and development of the LCC Model as a `` real-time '' cost control mechanism. This requires altering the bing footing from discounted to nominal costs. Estimates of capital costs will be replaced by the existent monetary values paid. Changes may besides be required to the cost dislocation construction and cost elements to reflect the plus constituents to be monitored and the degree of item required.

Targets are set for the operating costs and their frequence of happening based ab initio on the estimations used in the old phases. These marks may alter with clip as more accurate information is available, either from the existent plus operating costs or from benchmarking with other similar assets.

Phase 6 Implement and monitor Life Cycle Costing analysis

Execution of the LCC analysis involves the uninterrupted monitoring of the existent public presentation of the capital good/asset during its operation and care stages to place countries in which cost nest eggs may be made and to supply feedback for future life rhythm bing planning activities.

2. 4 Life Cycle Costing Model

An appropriate LCC theoretical account is provided in Fig. 2. 7 by Woodward (1997) . The theoretical account shows in the first measure the cost elements of involvement are defined from the position of manufacturer/supplier and of the customer/user. The 2nd measure defines the cost construction to be used, which will ensue in the possible trade-off relationships. The following measure is to find the mathematical relationship between the costs. The 4th measure is to set up a methodological analysis to measure the trade-off points of LCC sing all the relationships and uncertainness. Finally we get the LCC analysis consequences.

Fig. 2. 7 the LCC analysis theoretical account (Woodward, 1997)

2. 4. 1 Cost elements

Estimating the entire LCC requires breakdown of the capital good/asset into its component cost elements over clip. The degree to which it is broken down will depend on the intent and range of the LCC survey and requires designation of:

important cost generating activity constituents

the clip in the life rhythm when the work/activity is to be performed

Relevant resource cost classs (e. g. labor, stuffs, fuel/energy)

Woodward (1997) identified the undermentioned of import cost elements when carry oning the LCC analysis:

Acquisition costs

Life of the merchandise or system

Discount rate and rising prices

Operating and Care costs

Disposal cost

Information and feedback

Uncertainty and sensitiveness analysis

For the last two points: Information and feedback is required to prove whether the LCC computations are accurate ; the uncertainness takes different rising prices and discounting scenarios into history ; the sensitiveness analysis measures the public presentation fluctuations and design options. For case, if a little alteration in a parametric quantity consequences in a big alteration in result, the result is sensitive to that parametric quantity.

Costss associated with LCC elements may be farther allocated between repeating and non-recurring costs. LCC elements may besides be estimated in footings of fixed and variable costs. To ease control and decision-making and to back up the Life Cycle Costing procedure, the cost information should be collected and reported in a mode consistent with the defined LCC dislocation construction.

2. 4. 2 Cost dislocation construction

In order to carry on a LCC analysis it is necessary to make a construction that facilitates the designation of undertaking costs in each of the life rhythm stages. The British Standard 5760, portion 23, has a cost dislocation construction (CBS) that identifies all relevant costs classs in all appropriate life rhythm stages. The life rhythm cost dislocation construction has five degrees (Fig. 2. 8) :

Fig. 2. 8 LCC break-down constructions

Flat 1: The undertaking degree has four stages: design, production, installation direction and disposal.

Flat 2: The stage degree break down the four stages into their several cost classs, viz. the design and development costs ; the production and assembly costs ; the operation, service, support and care costs ; and the remotion and disposal costs.

Flat 3: The class degree takes each class and subdivides it into its cost elements. The design and development costs include the costs related to research and development, technologydesign, development and trials, and design certification. The production and assembly costs comprise fabrication and assembly, installation building, and initial logistic support costs. The operation, service, support and care costs contain operations of the system in the field, maintaining the system up to an acceptable criterion through service and care, and prolonging care and logistic support throughout the system life rhythm. Finally, the remotion and disposal costs of the system are the estimated value of a system at the terminal of its expected life, including pulverizing cost, recycling or recycling cost and redemption value (Blanchard et al. , 1995 ; Kumar et al. , 2000) .

Flat 4: The element degree takes the classs from degree 3 and interrupt them down into their bomber cost elements. For case, the costs related to research and development can be disaggregated into the costs of forces, informations aggregation, historical information analysis and other elements. The cost of operation in the field costs can be broke down into the cost of electric, natural gas, H2O etc.

Flat 5: The undertaking degree is the entire cost of all the resources required to finish a undertaking.

Fig. 2. 9 shows a LCC dislocation construction based on Blanchard et Al. (1995) .

Life Cycle Costing (LCC)

Design

Production

Facility direction

Disposal

Design and development

Production and assembly

Operations service and care

Removal and disposal

Research & A ; development

Fabrication and assembly

Operationss

Engineering design

Manufacturing technology

Tools and trial equipment

Fabrication

Inspection and trial

Quality control stuff

Packing and transporting

Service and care

System technology

Electrical design

Mechanical design

Dependability

Maintainability

Human factors

Logistic support analysis

Maintenance/support forces

Spare/repair parts

Trial and support equipment

Transportation system and handling

Maintenance/support preparation

Maintenance/support installations

Maintenance direction

Technical informations

Computer resources

System downtime

Construction

Fabrication installations

Trial installations

Operational installations

Care installations

Development and trial

Engineering theoretical accounts

Trial and rating

Design certification

Initial logistic support

System alterations

Program direction

Provisioning

Initial stock list direction

Technical informations readying

Initial preparation

Training equipment

Trial and support equipment

Fig. 2. 9 LCC dislocation construction (based on Blanchard et al. , 1995)

Estimating cost elements

The method used to gauge the cost elements in LCC computations will depend on the sum of information available. By definition, elaborate cost informations will be limited in the early phases, peculiarly during the design/acquisition stage. Cost informations during these early phases will necessitate to be based on the cost public presentation of similar plus constituents presently in operation. Where new engineering is being employed, informations can merely be based on estimated unit cost parametric quantities specified or suggested by the technician. More information on the plus constituent costs will go available during the usage of the capital good/asset, enabling more complete and descriptive costs to be defined.

2. 4. 4 The estimating cost relationships

The bulk of the cost drivers are determined and locked up in the design stage. This stage determines the dependability, maintainability and the effectivity of the system and its constituents. It is of import to hold a good apprehension of how specified assets or systems will execute in the hereafter.

Dependability is the chance that a merchandise manufactured to a given design will run throughout a specified period without sing a indictablefailure, when maintained in conformity with maker 's instructions and non capable to the environmental or operational emphasiss beyond bounds stipulated by the maker or put Forth in the purchase understanding (Moss and Dekker, 1985) .

Maintainability is that component of merchandise design concerned with guaranting that ability of the merchandise to execute satisfactorily can be sustained throughout its intended utile life p with minimal outgo ofmoneyand attempt understanding (Moss and Dekker, 1985) .

A system is technically available when it can run into the throughput where its client agreed on. Availability of a system is typically measured as a factor of itsA dependability. The System Availability is the chance that a system will be in a status to execute its intended map when. As widely recognized, the expression for system handiness is:

System availability= (2. 3)

In general it can be stated that LCC are mostly determined by the system handiness (A) demands set by the client:

LCC = C (A) acquisition + C (A) maintenance+ C (A) downtime+ Cdisposal (2. 4)

A (2. 5)

Where

MTBF: Mean-Time-Between-Failures and MTBF measures the system uptime

MDT: Mean-Down-Time and MDT measures the system downtime

The most of import facet of LCC in the design stage is the average clip between failures (MTBF) of the system. MTBF is defined as the mean clip before the first failure of a repairable system occurs (Kumar et al. , 2000) . On one manus MTBF plays an of import function in the costs of the design stage, increasing the MTBF of the system will increase the system 's acquisition cost (A-ner et al. , 2008) . On the other manus it besides plays an indispensable function in the care costs of the life rhythm, viz. , increasing the MTBF of the system will cut down the care costs.

The other of import facet is the clip the system is expected to be out of operation when a failure occurs. Although system 's MTBF are rather long, the mean down clip (MDT) determines the costs of non runing for each system failure. Therefore OEMs should do certain these down times are every bit low as possible.

The relationship between LCC and system handiness is complex because alterations in system handiness can increase certain LCC constituents and lower others. Thus it means that there will be a trade-off point between the MTBF, MDT and the LCC. Elaborate treatments will be made in the undermentioned chapters.

2. 5 Discounting and Inflation

Discounting and rising prices are two of import constituents which should be treated carefully when ciphering the LCC.

Discounting is a method where the investing for a future period is adjusted to the clip value of money by a price reduction rate. A price reduction rate is the per centum of difference between the value of an investing paid in the present and the value of an investing paid in the hereafter. Besides, in LCC analysis it is common to take into history rising prices rates for the future period. In order to take some uncertainness into history different rates can be chosen. The associated price reduction rate should be used with attention, since there are differences between existent and nominal price reduction rates. The former excludes rising prices and the latter includes rising prices.

In concern activities, price reduction rates are normally based on market involvement rates, that is, nominal involvement rates which include the investor 's outlook or general rising prices. Market involvement rates by and large serve as the footing for the choice of a nominal price reduction rate, which is used to dismiss future costs expressed in current dollars. In contrast, the existent price reduction rate needed to dismiss changeless dollar sums to show value reflects merely the existent gaining power of money, non the rate of general rising prices (Fuller and Petersen, 1996) . The existent price reduction rate, vitamin D, can be derived from the nominal price reduction rate, D, if the rate of rising prices, I, is known. The relationship is as follows:

(2. 6)

Then the general expression for the LCC present-value theoretical account is:

(2. 7)

Where

LCC= entire LCC in present-value

Ct= amount of all relevant costs, including initial and future costs

N= figure of old ages in the survey period, and

d= existent price reduction rate used to set hard currency flows to show value

Furthermore, the price reduction rate is likely to alter from period to period and there are many price reduction rates. When utilizing the existent price reduction rate in present value computations, cost should be expressed in changeless dollars. Taxs and depreciation allowances should be accounted for in LCC computations, every bit good as any local value consequence. By and large, the straight-line method of depreciation is used. It is simple to utilize and it is based on the rule that each period of the plus life should deprecate every bit (Ellis, 2007) .

2. 6 Decision

LCC analysis is used as the footing for monitoring and direction of costs over the capital good or plus 's life clip. It is basically a fiscal direction tool. In pattern, costs are by and large non expressed as existent or discounted costs but as nominal costs to enable a comparing of the predicted cost and the existent cost. This enables better anticipation and accommodation of the Life Cycle Costing theoretical account.

In the article wrote by Ellis (2007) , he stated that harmonizing to old surveies, old LCC computations did non bring forth dependable prognosiss. The estimated values might be rather different from existent values and that trying to gauge far in the hereafter could take to forecasting mistakes (Ashworth, 1996) . And LCC is non an exact scientific discipline, end products are merely estimations and estimations are non accurate. Even so, given robust and realistic premises, LCC analysis is a utile assistance for the customers/users to compare life rhythm cost of reciprocally sole assets and find which plus provides the best value per unit money spent (Barringer and Weber, 1996) . For the application of LCC analysis, realistic premises can be obtained from measuring the public presentation of similar assets, carry oning literature reappraisals, obtaining information from makers, sellers, contractors, and utilizing mean support and care costs (Robinson, 1996) and it should be performed early in the design stage.

The finding of costs is an built-in portion of the plus direction procedure. LCC analysis can be applied to any capital investing determination in which higher initial costs are traded for decreased hereafter disbursals.