

Australian/New Zealand Standard™

Life cycle costing— An application guide

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RECONFIRMATION

OF

AS/NZS 4536:1999

Life cycle costing—An application guide

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee OB/11, Life Cycle Costing.

The objective of this Standard is to establish a balanced set of guidelines for use throughout Australia by the private and public sector for life cycle costing which incorporates due consideration of product durability and reliability.

In preparing this Standard the Committee considered SAE ARP 4293—1992, *Aerospace Recommended Practice—Life Cycle Cost—Techniques and Applications*, ASTM E917—94, *Standard Practice for Measuring Life-Cycle Costs of Buildings, Building Systems* and IEC 300-3-3:1996, *Dependability management, Part 3: Application guide — Section 3: Life cycle costing*. It was decided by the Committee that there was no ISO document available with sufficient detail to be used as an Australian template; however, the combination of ideas from, in particular, the IEC and SAE documents were useful in providing an insight into life cycle costing.

This Standard simplifies the materials presented in the international reference Standards and focuses on identifying the most significant relationships between the different cost elements comprising the life cycle cost of a product.

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FOREWORD

Life cycle costing is a process to determine the sum of all expenses associated with a product or project, including acquisition, installation, operation, maintenance, refurbishment, discarding, and disposal costs. This Standard addresses the life cycle costing component of the economic evaluation. It also addresses some concepts of economic evaluation.

An economic evaluation involves analyzing and comparing product options at any stage of their development, with participation from all stakeholders. The aim of an economic evaluation is to determine the best option for a product to satisfy an identified need. It has as its philosophy the consideration of all effort (generally reduced to dollar values) required to satisfy that need.

In practice, decision making based on the life cycle cost (LCC) of a product often involves a combination of both quantitative and qualitative assessments. The quantitative results provide a baseline reference, but many important factors relevant to a decision may not be quantifiable in terms of costs. Value judgements based on experience are often used to account for such factors in the decision-making process. Such value judgements are generally qualitative. The qualitative assessments provide reinforcement for further support of the recommendations and decisions.

LCC and economic evaluation have the greatest value when applied early in the conceptual or development phase of a product, to optimize the basic design approach. However, they should also be used during the subsequent phases of the product life, to optimize other product decisions and facilitate efficient allocation of resources.

Life cycle costing may be applicable when analyzing the consequences and magnitudes of some risks, as well as when evaluating risk treatment options (see AS/NZS 4360).

Another type of economic evaluation is a value management study, and life cycle costing may also be applicable during the information, analysis and judgement phases (see AS/NZS 4183).

Other life cycle analyses include aspects other than money, finance or economic considerations. AS/NZS ISO 14040, provides a technique for assessing the environmental aspects and potential impacts associated with a product. These environmental aspects and potential impacts may then need to be costed as part of a life cycle costing analysis.

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Australian/New Zealand Standard **Life cycle costing—An application guide**

S E C T I O N 1 S C O P E A N D G E N E R A L

1.1 SCOPE This Standard details the process of life cycle costing and is intended for use by both customers (users) and suppliers of products. Following the process will give a dollar value representing the life cycle cost (LCC) of a product to satisfy an identified need, together with supporting and qualifying documentation.

This Standard specifically excludes consideration of revenues. LCC includes acquisition ownership and disposal costs. Where products being compared give rise to different potential revenues these must be considered in the broader evaluation process. LCC is one input to the evaluation process.

Definitions and discussion of the various components of life cycle costing are included. The Standard highlights many of the contributing elements for forming a life cycle costing model. It also provides definitions and descriptions to assist the development of a model along with the types of outputs that may suit a desired interpretation.

Worked examples of life cycle costing exercises are included with sample evaluation and presentation pro formas.

1.2 REFERENCED DOCUMENTS The following documents are referred to in this Standard:

AS

3960 Guide to reliability and maintainability program management

AS/NZS

4183 Value management

4360 Risk management

AS/NZS ISO

14040 Environmental management—Life cycle assessment—Principles and framework

1.3 DEFINITIONS For the purpose of this Standard, the definitions below apply.

1.3.1 Acquisition cost—the initial cost to gain possession of the completed product. Includes any research, development, testing and evaluation costs, as well as the investment and installation cost.

1.3.2 Base date—the date to which real costs refer, and to which discounted costs refer.

1.3.3 Cost driver—cost element which has a major effect on the LCC.

1.3.4 Cost element—an aspect of the product to be modelled. A cost element is generated from a collection of variables, rates, factors and constants expressed in money terms. The number and choice of cost elements depends on the purpose of the LCC analysis.

1.3.5 Dependability—the ability of the product to perform over its life as the user expects.

1.3.6 Discounted cost—the resulting value when real cost is discounted by the real discount rate, or when nominal cost is discounted by the nominal discount rate.

1.3.7 Disposal cost—the cost of removing a product after its usefulness has ended, including costs to decommission, dismantle, make environmentally safe, transport and dump. If the product or its elements are sold and the proceeds from the sale exceed the other costs of disposal, the product will have a disposal value that reduces the life cycle cost.

1.3.8 Life cycle cost (LCC)—the sum of Acquisition cost and Ownership cost of a product over its life cycle.

1.3.9 Life cycle—the time interval between a product's recognition of need or opportunity and its disposal.

1.3.10 Life cycle costing—the process of assessing the cost of a product over its life cycle or portion thereof.

1.3.11 Maintainability—the ability of a product, under stated conditions of use, to be retained in, or restored to, a state in which it can perform its required functions, when maintenance is performed under stated conditions and using prescribed procedures and resources.

1.3.12 Maintenance support—the provision of resources, including labour and materials, necessary for maintaining the dependability of the product during its service life (or ownership period).

1.3.13 Nominal cost—the expected price that will be paid when a cost is due to be paid, including estimated changes in price due to forecast changes in efficiency, inflation/deflation, technology and the like.

1.3.14 Nominal discount rate—the rate to use when converting nominal costs to discounted costs. The rate includes a component for general price inflation.

1.3.15 Ownership cost—summation of all operating expenses, maintenance, support and disposal costs borne by the owner or user of a complete product during its life cycle.

1.3.16 Product—the result of activities or processes that fulfil a required need. A product can be tangible or intangible, or a combination thereof. A product may include services (for example banking), hardware (for example parts), software (for example applications and/or tools), processed materials (for example raw materials) or a combination thereof.

1.3.17 Real cost—the cost expressed in values of the base date, including estimated changes in price due to forecast changes in efficiency and technology, excluding general price inflation or deflation.

1.3.18 Real discount rate—the rate to use when converting real costs to discounted costs. The rate does not include a component for general price inflation.

1.3.19 Reliability—the probability that a product will perform a required function under stated conditions for a stated period of time.

1.3.20 Stakeholder—any individual, group or organization that has an input or is affected by an action.

1.3.21 Support—the provision of personnel, training, maintenance, supply, transportation, computer support, storage and/or facilities necessary for the effective operation of a product.

1.3.22 Value management—a structured and analytical process which seeks to achieve value for money by providing all the necessary functions at the lowest total cost consistent with required levels of quality and performance. The Standard uses the term 'value management' as being synonymous with the terms 'value analysis' and 'value engineering'.

SECTION 2 LCC CONCEPT

2.1 OBJECTIVES OF LIFE CYCLE COSTING The objectives of life cycle costing are as follows:

- (a) Calculate a dollar value representing the LCC of a product as an input to a decision-making or evaluation process (see Figure 2.1 and Appendix A which outlines evaluation concepts), together with other inputs. The cost is based on a defined need associated with the product.
- (b) Support management considerations affecting decisions during any life-cycle phase.
- (c) Identify the attributes of the product which significantly influence the LCC (cost-drivers) of the product so that they can be properly managed.

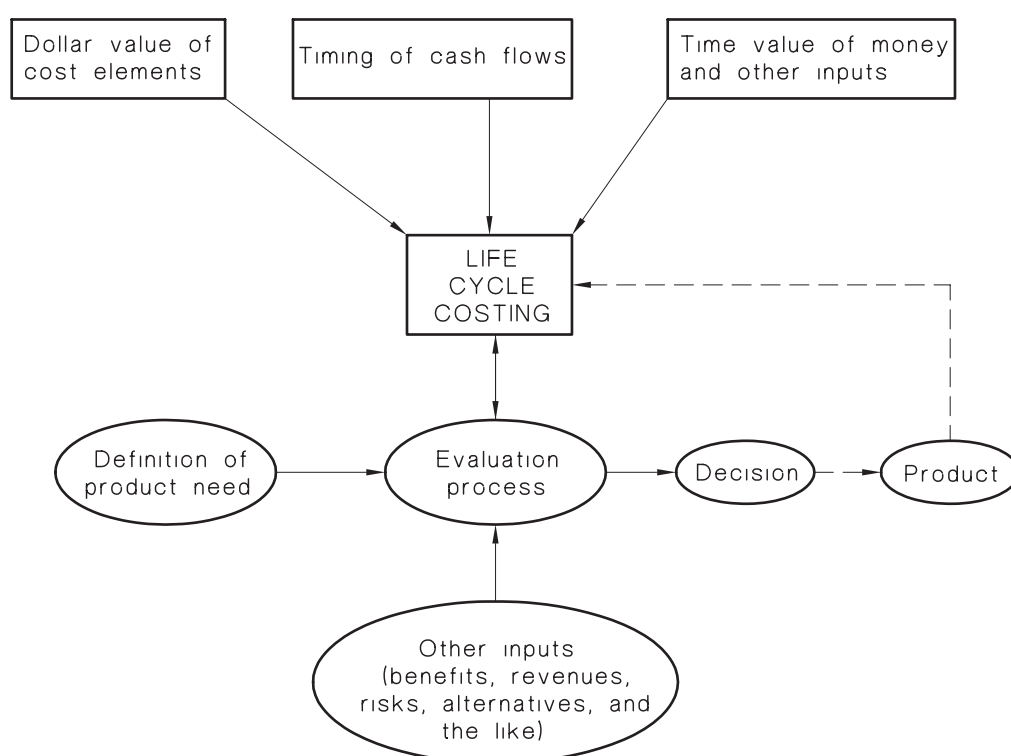


FIGURE 2.1 USE OF LIFE CYCLE COSTING

The purposes of LCC analysis may be categorized as related to either the evaluation of alternatives or financial planning. In most cases, however, the analyst will seek to satisfy both purposes, albeit, at different times in the product life cycle. Where the purpose relates only to evaluating alternatives, it is usually cost effective to model and analyze only the differences between each alternative. Where it is necessary to identify the full financial implications of a product management decision, then the full range of cost factors should be included in the analysis.

Depending on the purpose of the analysis, different ways of expressing the cost may be appropriate; that is, real cost, nominal cost, and discounted cost.

These three costs are defined in Clause 1.3. Additional information on how these three costs relate to each other is explained in Appendix B, together with details of inflation and discounting.

The following list shows the decision-making or evaluation processes that make use of life-cycle costing information, and the expression of cost normally used:

- (i) *Real costs*—usually applied to—
 - (A) identification of cost drivers and cost effective improvements;
 - (B) understanding product design;
 - (C) increasing user awareness of the benefits and costs of product and components, for products with short lives; and
 - (D) cost management of a product through its design, construction and operation.
- (ii) *Nominal costs*—usually applied to—
 - (A) allocation of future funds for the product under development or improvement;
 - (B) long-term financial planning and budgeting of capital and operating costs and revenue; and
 - (C) recording data on price performance.
- (iii) *Discounted costs*—usually applied to—
 - (A) evaluation and comparison of alternative design approaches, for products with long lives;
 - (B) assessing the impact of new technology;
 - (C) evaluation and comparison of alternative strategies for product use, operation, testing, inspection, maintenance, and the like;
 - (D) evaluation and comparison of different approaches for replacement, rehabilitation or retirement of ageing facilities;
 - (E) benefit-cost analysis and trade-off studies to determine the optimum performance, reliability, maintainability and other requirements;
 - (F) selecting amongst competing tenderers, for products with long lives;
 - (G) assessment of economic viability of products;
 - (H) selecting the optimal procurement policy; and
 - (I) enabling a common basis of comparison for products with significantly different cost profiles.

2.2 PRODUCT LIFE-CYCLE PHASES AND LCC Life cycle phases cover the life of the product, from the identification of need through to disposal. The various phases in this life cycle can be designated as follows and as shown in Figure 2.2:

- (a) Acquisition, which should include the following:
 - (i) Definition of need.
 - (ii) Conceptual design.
 - (iii) Preliminary design.
 - (iv) Detailed design and development.
 - (v) Production or construction.

- (b) Use and maintenance support.
- (c) Renewal and adaptation.
- (d) Disposal.

Life cycle costing analysis can be carried out during any or all phases of a product's life cycle. It can be used to provide input to decisions regarding product design, manufacture, installation, operation, maintenance support and disposal.

Early identification of acquisition and ownership costs enables the decision maker to balance performance, reliability, maintainability, maintenance support and other goals against life cycle costs. Decisions made early in a product's life cycle have a much greater influence on life cycle costing than those made late in a product's life cycle. The typical distribution of real costs over the phases of life cycles is indicated in Figure 2.2.

Experience has shown that by the end of the concept and definition phases of acquisition, more than half of the product's LCC may be committed by decisions made with respect to the product features, performance, reliability, technology and support resources. By the end of design and development phases, even more of the product's LCC may be fixed.

The timing of the life cycle costing analysis is very crucial to optimize the product and its associated costs. The flexibility in design trade-offs and options becomes increasingly limited as the product advances in its life cycle.

The life cycle costing process can be applied to the whole life cycle of a product or to part thereof. In the latter case, a partial estimate of the overall LCC will be obtained.

Such estimates are useful as they permit specific focus on comparative studies where only the cost differentials in various alternatives are to be assessed and compared. To obtain the maximum benefits, the period of time over which the life cycle costing analysis is made should be tailored to suit a particular product and the purpose of the analysis.

2.3 PRODUCT DECISIONS AND THE EFFECTS ON LCC A major portion of projected life cycle cost stems from the consequences of decisions made during the early phases of program planning and conceptual design. Figure 2.3 illustrates this principle.

It can be seen from Figure 2.3 that the greatest opportunity for influencing projected life cycle costs are realized during the early phases of the program.

It is the early decisions of defining product need, operating requirements and the support concept that commit a large percentage of the support resources expended during the product's operation phase.

Decision makers need to be aware of the LCC implications of decisions taken early in a product life cycle. Product-related decision support processes should rely on thorough and relevant analytical activities.

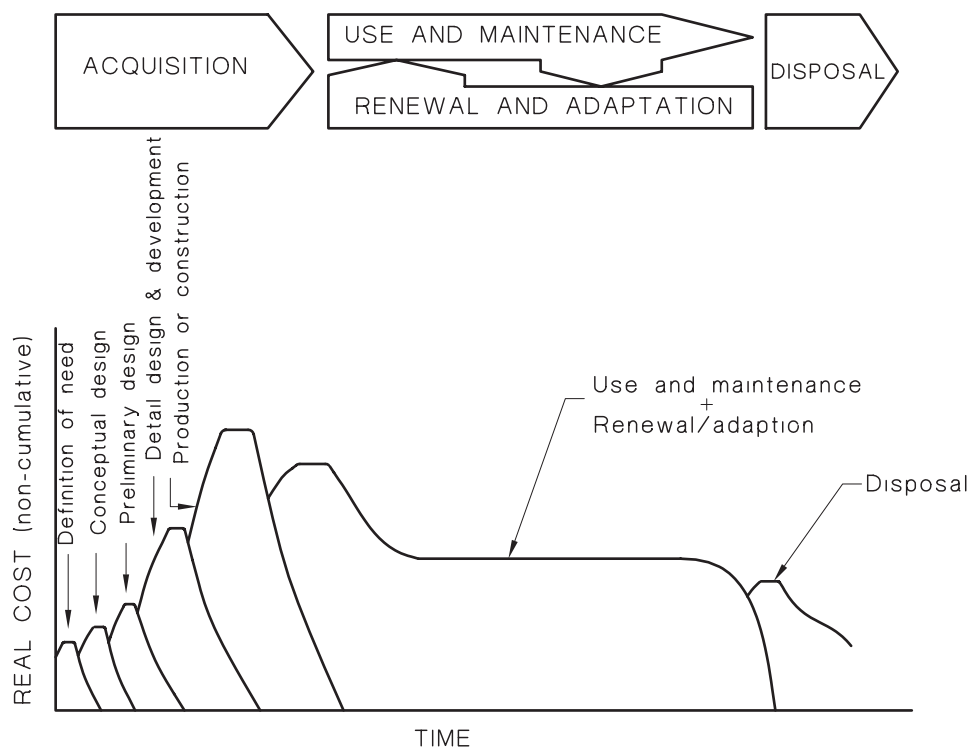
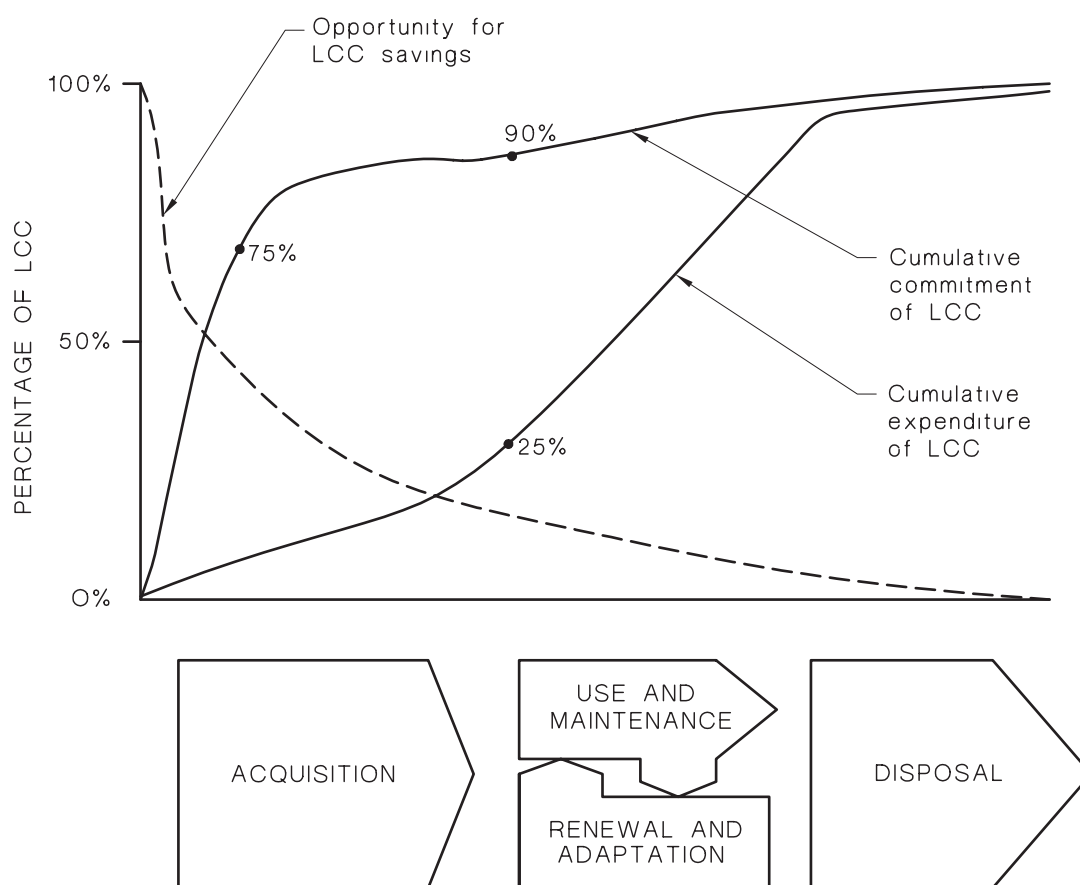


FIGURE 2.2 COSTS AND THE PHASES OF THE LIFE CYCLE



Acquisition	Use and maintenance/renewal and adaptation	Disposal
Review of alternatives Analysis of system concepts and options Selection of preferred system concept Analysis of new technology implications Analysis of support concepts Other resource analysis Analysis of finance options Make or buy Analysis Technology selection Product selection Source selection Construction analysis Produceability analysis Design trade-offs Performance tailoring Test and evaluation analysis System integration and verification Repair analysis Warranty trade-off Configuration management Environmental analysis OH&S analysis	Support port introduction analysis Review of supportability plans Performance monitoring Design/support/training/maintenance trade-offs Performance modifications Supportability modifications Operating and maintenance cost monitoring Repair analysis Warranty trade-off Configuration management Environmental analysis OH&S analysis Review of planned phase-out	Retirement cost impact Environmental analysis OH&S analysis Replacement/renewal scheme Disposal salvage value Redeployment/retraining of personnel

FIGURE 2.3 LIFE STAGES RELATED TO OPPORTUNITIES FOR LIFE CYCLE SAVINGS

SECTION 3 LCC MODEL

3.1 GENERAL An LCC model, like any other model, is a simplified representation of the real world. It abstracts the salient features and aspects of the product and translates them into cost figures. In order for the model to be realistic it should—

- (a) represent the characteristics of the product being analyzed including its intended use environment, maintenance concept, operating and maintenance support scenarios, and any constraints or limitations;
- (b) be comprehensive enough to include and highlight all factors relevant to LCC;
- (c) be simple enough to be easily understood and allow for its timely use in decision making, and future update and modification; and
- (d) be designed in such a way as to allow for the evaluation of specific elements of the LCC independent from other elements.

A simple LCC model is basically an accounting structure that contains terms and factors that allow for the estimation of costs associated with each of the cost elements constituting the LCC.

In some cases, a model may need to be specifically developed for the problem under study while for some other cases, commercially available models may be used. Each LCC model has its own flexibility and intended application. Knowledge of the contents and the conditions under which they apply are important in order to assure adequacy of their use. Before selecting a model, the amount of information needed should be identified together with the results or purpose of analysis. Someone familiar with the details of the model is needed to review it so as to determine the applicability of all cost factors, empirical relationships, elements, and other constants and variables in the model, and the relevance of the model to the purpose of the analysis (see Clause 3.3). Therefore, before using any existing LCC model, it should be suitably validated for the life cycle costing study under consideration. To do this, the cost factors and other parameters from a known example along with the operational scenario should be used to assess the extent to which the model provides realistic results.

Many products are designed to have very long lives; for example, buildings or ships. For such products, a number of costs will occur at intervals during the life of the product, and techniques to deal with these should be incorporated in the model.

3.2 LCC BREAKDOWN INTO COST ELEMENTS In order to estimate the total LCC, it is necessary to break down the product into its constituent cost elements over time. These cost elements should be individually identified such that they can be distinctly defined and estimated. The identification of the elements and their corresponding scope should be based on the purpose and scope of the LCC study.

One approach, often used to identify the required cost elements, involves the breakdown of the product into lower cost-generating activities (cost breakdown structure), cost categories and life cycle phases. This approach can best be illustrated by the use of a three dimensional matrix shown in Figure 3.1. This matrix involves identification of—

- (a) breakdown of the product to lower cost-generating activities (for example, the work breakdown structure);
- (b) the time in the life cycle when the work/activity is to be performed (for example, the life cycle phase);
- (c) the cost category of applicable resources such as labour, materials, fuel/energy, overhead, transportation/travel and the like.

This kind of approach has the advantage of being systematic and orderly thus giving a high level of confidence that all relevant cost elements have been included. Appendix C identifies typical activities the costs of which should be addressed.

Costs associated with LCC elements may be further allocated between recurring and non-recurring costs so that the sum of all recurring and non-recurring costs equals LCC. LCC elements may also be estimated in terms of fixed and variable costs. The latter costs, for example, will vary with the number of copies of the product to be produced and put into use.

To facilitate control and decision making, and to support the life cycle costing process, the costs, information should be collected and reported. The cost information to be consistent with the defined LCC breakdown structure.

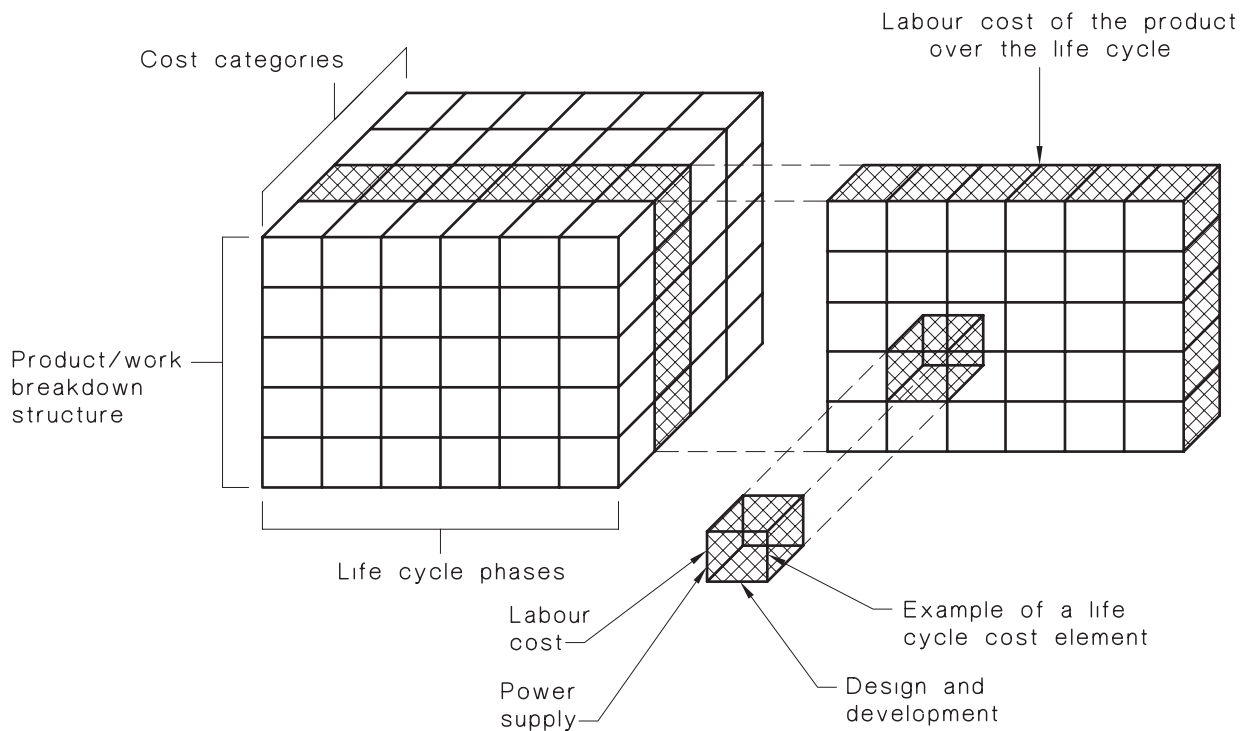


FIGURE 3.1 COST ELEMENT CONCEPT

3.3 METHODS FOR ESTIMATING COST ELEMENTS The method used to estimate the cost elements in the LCC calculations will be influenced by the feasibility of obtaining these estimates. Factors affecting this feasibility include the newness of the technology used, the degree of certainty about the use to which the particular product is to be subjected, and the certainty of the required life for the product. Normally the greatest influence over these factors, and therefore on the method used, will be the stage of the life cycle at which the analysis is undertaken. The more detailed the information about the actual technology to be used, its behaviour and the use to be made of the product, the more feasible a detailed estimate of cost elements utilizing engineering analysis.

The engineering analysis may be used to provide an accurate estimate of the cost when more information on technology behaviour and use of the product is known.

Alternatively, the less known about the specific technology or use to be made of the product, the more likely that cost elements can only be estimated through the drawing on analogous products, or using parametric cost element relationships. Parameters such as the dimensions, technologies employed or deployment details may provide the most accurate and feasible estimate of cost elements. This situation could lead to uncertainty about the LCC of the product. The level of uncertainty should be made clear in the documentation of the LCC analysis.

In any case, attempts to obtain accurate cost elements should be consistent with both the ability to predict these costs and the potential for these cost elements to influence the decision being taken. It should also take account of the size of the investment being made.

In summary, there are three basic methods for estimating cost elements. These are as follows, in descending order of the required knowledge about the product and its use:

- (a) *Engineering cost method* Involves the direct estimation of a particular cost element by examining the product component-by-component or part-by-part. It uses standard established cost factors, for example, firm engineering and manufacturing estimates, to develop the cost of each element and its relationship to other elements, i.e. cost element relationships. Estimates should be updated to the present time by the use of annual discounting and escalation factors.
- (b) *Analogous cost method* Involves cost estimation based on experience with the same or similar products and technology. It generally utilizes less detailed historical data, updated to reflect the real costs to the base date, or the variation between the historical and new products.

This technique may be the least complex and least time consuming. It is easily applied to components of the system for which there is some experience and actual data. The accuracy of this method is heavily dependent on the relevance and appropriateness of the analogy used.

- (c) *Parametric cost method* Uses significant parameters and variables to develop cost element relationships that are, usually, in the form of equations. A parameter in cost element relationships reflects a conversion factor from one system of units to another. It may be a price or an empirically derived ratio. For example, labour costs for steel construction may be calculated by using a ratio of tonnes of steel to labour hours.

The three methods of estimating cost elements are further explained with appropriate examples in Appendix D.

A variable in the cost element relationships of parametric cost methods generally characterizes resource consumption over time and generates cost. It may be a physical or performance measure such as failure rate, preventive maintenance labour-hours per unit of item or component.

The cost element relationships equation reflects an analyst's assessment of how costs are generated. Often, when a detailed theoretical or analytical relationship cannot be developed, a statistically derived relationship, for example, regression analysis, may be used.

SECTION 4 LIFE CYCLE COSTING PROCESS

4.1 GENERAL In order to produce results that can be usefully and correctly employed, any LCC analysis should be conducted in a structured and well-documented manner using the following steps:

- (a) LCC analysis plan.
- (b) LCC model development or selection.
- (c) LCC model analysis.
- (d) LCC analysis documentation.
- (e) Review of LCC results.
- (f) LCC analysis update.

The above steps may be performed in an iterative fashion if efforts at any stage indicate a need to revisit and modify work accomplished at earlier stages. Assumptions made at each step should be rigorously documented to facilitate such iterations and to aid in interpreting the results of the analysis (see Figure 4.1).

LCC analysis is a multidisciplinary activity. The analysts should be familiar with the philosophy that underlies LCC (including typical cost elements, sources of cost data and financial principles) and should have a clear understanding of the methods of assessing the uncertainties associated with cost estimation. Depending upon the scope of the analysis, it will be important to obtain cost inputs from individuals who are familiar with all phases of the product life cycle. This may include representatives of both the supplier(s) and the customer(s).

The task of conducting LCC analysis activities is often resource intensive, with the majority of time devoted to the collection and evaluation of data. The actual modelling of the data can be completed in a relatively short period of time.

For those users who conduct LCC analysis for product management, or other purposes, on a routine basis, resource savings can result from the development and maintenance of data-capturing mechanism. This may require establishing new information systems or modifying existing systems.

The primary purpose of these data capture and maintenance capabilities is the cost-effective provision of relevant and accurate data to support the LCC analysis and related decision-making processes within the organization. If a LCC data system is developed, its detailed requirements should be tailored to the user's specific LCC analysis requirements.

Worked examples of the life cycle costing process are shown in Appendix E, and should follow the above-listed documentation steps.

4.2 LCC ANALYSIS PLAN The LCC analysis should begin with the development of a plan that addresses the purpose and scope of the analysis. The plan should address the following elements:

- (a) Define the analysis objectives in terms of the outputs that should be provided to support the management decisions to be made. Typical objectives are—
 - (i) determination of the LCC for a product, in order to support planning, contracting, budgeting or similar needs;
 - (ii) evaluation of the impact of alternative courses of action (such as design approaches, product acquisition or support policies or alternative technologies) on the LCC of a product; or

- (iii) identification of cost elements, which act as cost drivers for the LCC of a product in order to focus design, development, acquisition or product support efforts.
- (b) Delineate the scope of the analysis in terms of the product(s) being studied, the time period (life cycle phases) to be considered, the use environment and the operating and maintenance support scenario to be employed.
- (c) Identify any underlying conditions, assumptions, limitations and constraints (such as minimum product performance or availability requirements, or maximum capital cost limitations) which might restrict the range of acceptable options to be evaluated.
- (d) Identify alternative courses of action to be evaluated (if this forms part of the analysis objective). The list of proposed alternatives may be refined as new options are identified, or as existing options are found to violate the problem constraints.
- (e) Provide an estimate of resources required and a reporting schedule for the analysis, to ensure that LCC analysis results will be available to support the decision-making processes for which they are required.

The analysis plan should be documented at the beginning of the LCC analysis process to provide a focus for the rest of the work. The plan should be reviewed by the intended users of the analysis results, both from a customer and a supplier perspective, to ensure that their needs have been correctly interpreted and clearly addressed.

4.3 LCC MODEL DEVELOPMENT An LCC model, of sufficient detail to meet the objectives of the analysis, should be developed or selected in accordance with the following procedure:

- (a) Create or adopt a cost breakdown structure (CBS) that identifies all relevant cost categories in all appropriate life cycle phases. Cost categories should be broken down into smaller components (activities, sub-activities, and the like) until a required level is reached in the CBS where a cost can be readily estimated for each individual cost element. Where available, an existing cost breakdown structure may provide a useful starting point for development of the LCC breakdown structure. See Clause 3.2.
- (b) Identify cost elements that will not have a significant impact on the overall LCC of the product(s) under consideration. For comparative studies of alternative courses of action, identify cost elements that will not vary between alternatives. These elements may be eliminated as they affect all options similarly if a comparison of relative (rather than absolute) LCC figures is adequate for the purpose of the analysis.
- (c) Select a method (or methods) for estimating the cost associated with each cost element to be included in the model (see Clause 3.3).
- (d) Determine the data required to develop these estimates, and identify possible sources for the data.
- (e) Identify any uncertainties that are likely to be associated with the estimation of each cost element.
- (f) Integrate the individual cost elements into a unified LCC model which will provide the LCC outputs required to meet the analysis objectives, such as total LCC figures at the system level (and at lower levels, if required) and LCC figures over time. The model should take into account the time value of money.

- (g) Review the LCC model to ensure that it is adequate to address the objectives of the analysis. Ensure that all cost elements have been included, that the elements are correctly rolled-up into higher-level totals and that the time value of money is accurately reflected.

The LCC model including all assumptions should be documented to guide and support the subsequent phases of the analysis process.

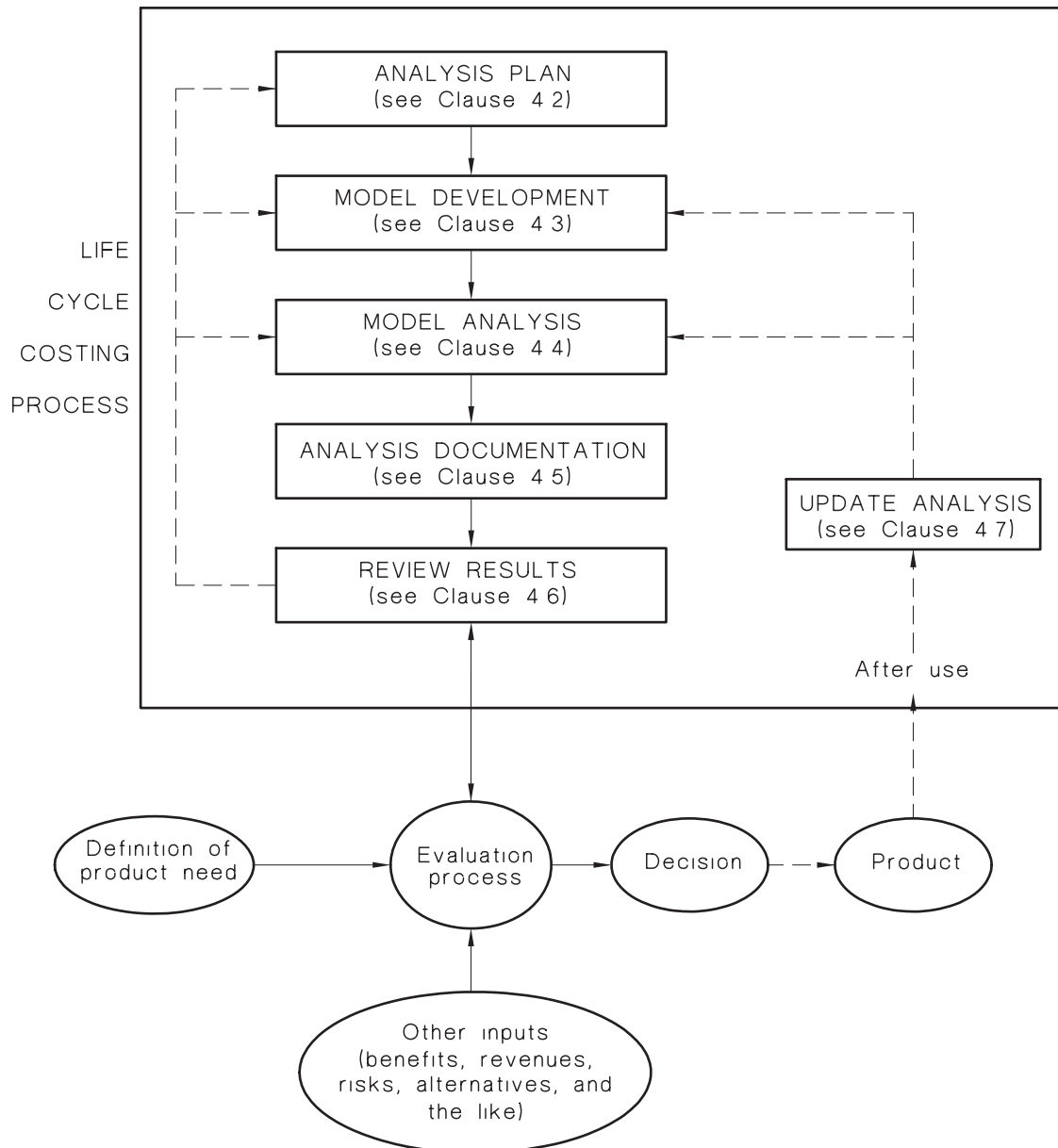


FIGURE 4.1 THE LIFE CYCLE COSTING PROCESS

4.4 LCC MODEL ANALYSIS The LCC analysis, which involves the generation and analysis of LCC model results, should include the following steps:

- (a) Obtain data and develop cost estimates and their timing for all the basic cost elements in the LCC model.
- (b) Validate the LCC model with available historical data, if possible.
- (c) Obtain the LCC model results from each relevant combination of operating and support scenarios defined in the analysis plan.
- (d) Identify cost drivers by examining LCC model inputs and outputs to determine the cost elements that have the most significant impact on the LCC of the product(s).
- (e) Quantify any differences (in performance, availability or other relevant constraints) between any alternatives being studied, unless these differences are directly reflected in the LCC model outputs (for example, through the evaluation of the cost of unavailability).
- (f) Categorize and summarize LCC model outputs according to any logical groupings (for example, fixed or variable costs, recurring or non-recurring costs, acquisition or ownership costs, direct or indirect costs) which may be relevant to users of the analysis results.
- (g) Conduct sensitivity analyses to examine the impact of variations to assumptions and cost element uncertainties on LCC model results. Particular attention should be focused on cost drivers, assumptions related to product usage and assumptions related to the time value of money.
- (h) Review LCC outputs against the objectives defined in the analysis plan to ensure that all goals have been fulfilled and that sufficient information has been provided to support the required decision. If the objectives are not met, additional evaluations and modifications to the LCC model may be required.

The LCC analysis (including all assumptions) should be documented to ensure that the results can be verified and readily replicated by another evaluator, if necessary.

4.5 LCC ANALYSIS DOCUMENTATION The results of the LCC analysis should be documented in a report, which allows users to clearly understand both the outcomes and the implications of the LCC analysis, including the limitations and uncertainties associated with the results. The report should contain the following:

- (a) *Executive summary*—a brief synopsis of the objectives, results, conclusions and recommendations of the analysis. This summary is intended to provide an overview of the analysis to the decision makers, users and other interested parties.
- (b) *Purpose and scope*—a statement of the analysis objective, product description including a definition of intended product use environment, operating and support scenarios, assumptions, constraints, and alternative courses of action considered in the analysis, as discussed in Clause 4.2. (Since this information is included in the LCC analysis plan, this plan may be included in the documentation as reference.)
- (c) *LCC model description*—a summary of the LCC model, including relevant assumptions, a depiction of the LCC breakdown structure, an explanation of the cost elements and the way in which they were estimated, and a description of the way in which cost elements were integrated including methods of accounting for the time value of money, as discussed in Clause 4.3, and the presentation in a form similar to the one set out in Appendix F.
- (d) *LCC model analysis*—a presentation of the LCC model results, including the identification of cost drivers, the results of sensitivity analyses, and the output from any other related analysis activities, as discussed in Clause 4.4.