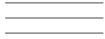




LIFE-CYCLE COSTING



BETTER PRACTICE GUIDE

December 2001





Auditor-General's Foreword

This Better Practice Guide is intended to assist APS managers responsible for decisions relating to acquiring, owning, operating and using major assets or products, such as buildings, vehicles, and major plant. The guide can also assist in decision-making when multiple items of equipment of lower cost items such as IT equipment, photocopy machines and the like are under consideration.

The purpose of this Guide is primarily to:

- raise awareness of the need to consider future costs associated with asset or product acquisition, including maintenance, operational and energy costs associated with the acquisition's long-term use;
- complement and expand on the life-cycle costing information presented in the ANAO's Asset Management Handbook;
- assist in making decisions on acquiring an asset or product, particularly through an economic evaluation process; and
- assist in assessing or auditing the decision-making process for significant acquisitions.

The Guide arose from the ANAO's 1998 report on life-cycle costing in Defence. The parliamentary Joint Committee of Public Accounts and Audit reviewed the report in 1999 and indicated its support for the recommendations. The ANAO subsequently decided to revise the guide included in the audit report and issue it as part of its series of Better Practice Guides.

The ANAO appreciates the assistance of Strategic Facility Services Pty Ltd in preparing this Guide. It was completed after considering comments kindly provided by the Department of Finance and Administration, the Department of Defence, Australian Federal Police, the Institution of Engineers and Mr Roger Burritt of The Australian National University. Thanks to all those contributors.

P J Barrett

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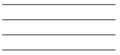
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Introduction

Owners, users and managers need to make decisions on the acquisition and ongoing use of many different assets, including items of equipment and the facilities to house them. The initial capital outlay is usually clearly defined and is often a key factor influencing the choice between alternative assets. There are, however, other future costs that should also be considered if the best outcome is to be achieved. The process of identifying and documenting all the costs involved over the life of an asset is known as life-cycle costing (LCC).

The Australian and New Zealand standard Life Cycle Costing - An application Guide (AS/NZS 4536:1999) details the process of LCC. The standard defines it as the process of assessing the cost of a product over its life cycle or portion thereof.

Future costs associated with the use and ownership of an asset are often greater than the initial acquisition cost and can vary significantly between alternative solutions to a given operational need. Consideration of the costs over the whole life of an asset provides a sound basis for decision making. With this information, it is possible to:

- assess future resource requirements (budgeting);
- assess comparative costs of potential acquisitions (investment appraisal);
- decide between sources of supply (source selection);
- account for resources used now or in the past (reporting and auditing);
- improve system design;
- optimise operational support; and
- assess when assets reach the end of their economic life and replacement is required (disposal).

The LCC process can be as simple as a table of expected annual costs or it can be a complex (computer) model that allows the creation of scenarios based on assumptions about future cost drivers. The scope and complexity of the model should reflect the complexity of the asset under investigation, the ability to predict future costs and the significance of the future costs to the organisation.



Impact of future costs on current decisions

When planning the acquisition of a major asset, organisations spend considerable time and effort in making an economic evaluation of the initial (capital) cost. This evaluation typically considers the:

- required size or capacity of the item;
- operating performance requirements;
- physical appearance or image projected;
- the capital cost; and
- alternative product options.

Future costs are less visible, as they are often “hidden” within general operating expenses, but they can have a significant impact on the future viability of an organisation. These future costs will arise from the following:

- **Operational needs,**
including labour, equipment, insurances and overhead charges. Major plant with complex operational processes will require expert personnel and significant supporting infrastructure.
- **Consumables,**
such as power, fuel, water, toner and ink.
- **Maintenance and Minor Repairs,**
including labour, parts, materials, and overhead charges to maintain the asset at the desired condition and performance level. These maintenance costs may arise through inhouse resources or by the engagement of external contractors.
- **Upgrade and Renewal,**
including major repairs, refurbishment, renewals and overhauls to extend the life of the asset or equipment.
- **Disposal,**
including costs associated with selling, demolishing and safely disposing the remnants of the asset.

The scale of these costs depends on the level and frequency of usage of the asset.

There are also broader environmental implications that flow from the decision to acquire a major asset. Resources are used during the creation, operation and disposal phases, with the potential to affect environmental sustainability, and there may also be direct environmental impacts. The study of these broader issues is often termed life-cycle assessment. This guide does not specifically address these broader issues but they should be part of a complete assessment of the merit of a specific project.

Significance to the APS

The Australian Public Service (APS) is subject to virtually the same cost impacts experienced by the private sector and accordingly needs to consider the whole-of-life impact of decisions regarding the acquisition of major assets.

The overall costs involved in owning, operating and maintaining an asset, from initial planning through to disposal, are not always obvious within the APS, as different sections or agencies can be responsible for each segment of the process.

An hypothetical scenario is illustrated below:

- The decision to acquire or lease an asset is made by the purchasing section of an organisation. The decision is made in isolation from the end users, and mainly involves issues of primary concern to the purchasing area.
- The end users are in another section of the organisation, separate from the purchasing area. The users use the asset in a way that directly supports the mode of operation of their particular section. This method of operation may not be known or anticipated by the purchasing area.
- The end users pay for the consumables, operating costs and any associated maintenance costs. The scope and scale of these services do not affect the purchasing section, which may be unaware of the impact of purchasing decisions on these costs.
- When the asset no longer supports the level of operation required by the end users, it is "handed over" to the disposal section. The method and cost of disposal do not concern the end users, provided that they can obtain the replacement asset in time.

Separation of roles and responsibility limits the chance of learning from past experience. Given the above scenario, the documentation of the full cost of owning and operating an asset is difficult to co-ordinate.

To achieve the benefits of LCC, senior management should actively encourage its use and respond positively to the conclusions that the process delivers. The potential savings can release financial resources for use in other aspects of program delivery, with benefits to both end users of government services and to the general public who fund them.

The *Commonwealth Procurement Guidelines* state that the core principle governing Commonwealth procurement is value for money, a concept evaluated on a whole of life basis of the goods or services being procured. Officials buying goods and services need to be satisfied that the best possible outcome has been achieved taking into account all relevant costs and benefits over the whole of the procurement cycle.¹

The *Commonwealth Policy Principles for the Use of Private Financing* establish policy principles and processes for the use of private financing by Commonwealth agencies. They state that, in assessing a private financing proposal, value for money is to be assessed by means of a business

1 *Commonwealth Procurement Guidelines and Best Practice Guidance* issued by the Minister for Finance and Administration, September 2001 pp5 and 6.

case that analyses the proposal on a whole-of-government basis and takes into account whole-of-life costing.²

How to use this guide

This Better Practice Guide provides a general introduction to the concepts and application of LCC so that APS managers can:

- identify issues to consider when making decisions relating to the acquisition, operation and maintenance and disposal of major assets;
- understand the range of information available to assist them in making decisions; and
- use LCC analysis to improve decision-making.

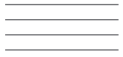
The Guide is not designed to be a step by step implementation guide, but rather to enable the reader to better understand the basic concepts underlying LCC and how best to access implementation resources.

Managing risk

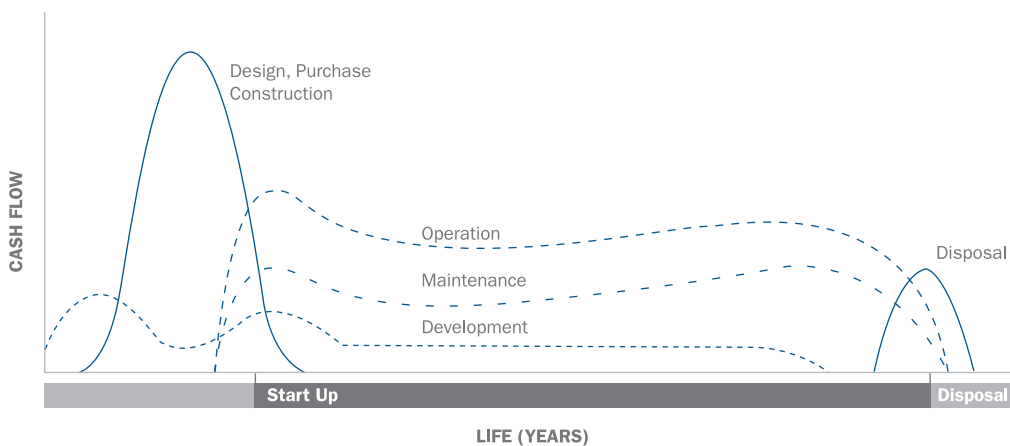
The APS manager is expected to consider potential events that can have an impact on the achievement of outputs and outcomes and on the costs of delivery of services. LCC assists in assessing future costs and can therefore also provide useful input to risk analysis. The techniques of risk management can also be applied to the prediction of future costs for inclusion in a LCC analysis. Several publications are available for those conducting risk management studies.³

2 *Commonwealth Policy Principles for the Use of Private Financing* issued by the Minister for Finance and Administration, October 2001, paragraphs 25 and 41.

3 See Standards Australia/Standards New Zealand joint standard AS/NZS 4360:1999 *Risk Management*; Standards Australia/Standards New Zealand HB143:1999 *Guidelines for managing risk in the Australian and New Zealand public sector*; and Management Advisory Board/ Management Improvement Advisory Committee *Guidelines for Managing Risk in the Australian Public Service* 1996.



Life-cycle Concepts



The process of life-cycle costing (LCC) fundamentally involves:

- assessing costs arising from an asset over its life cycle; and
- evaluating alternatives that have an impact on this cost of ownership.

An asset⁴ can be any item that has a value to an organisation over time. Items such as buildings, physical plant and equipment and computer software are normally regarded as assets.

Australian Standard AS/ NZS 4536:1999 defines life-cycle cost as the sum of acquisition cost and ownership cost of an asset over its life cycle from design stage, manufacturing, usage, maintenance and disposal.

Consideration of all these costs is important, even if they are funded from different sources within an organisation.

4 Statement of Accounting Concepts 4 Definition and Recognition of the Elements of Financial Statements, issued by the Australian Accounting Research Foundation, defines 'assets' as future economic benefits controlled by the entity as a result of past transactions or other past events.

The life of an asset

The life cycle of an asset is defined as the time interval between the recognition of a need or an opportunity through the creation of an asset to its final disposal. This life cycle is characterised by a number of key stages:

- initial concept definition;
- development of the detailed requirements, specification or documentation;
- construction, manufacture or purchase;
- defects liability period and early stages of usage or occupation;
- prime period of usage and functional support, with the associated series of upgrades and renewal processes; and
- the situation at the end of the asset's useful life.

The diagram at the beginning of this section shows a typical life cycle cost profile for an asset, from its design to its disposal. The diagram is not drawn to a consistent time scale. The middle operational period is generally much longer than shown in the diagram.

Assets are formed from a series of actions. There are usually a series of upgrades and renewal processes required during the life of an asset that become necessary as components of the asset reach the end of their useful life during the life span of the total asset.

The life of an asset will be influenced by both the failure of its key components and by its ability to continue to provide a required service. Many assets reach the end of their useful life before they become unserviceable. Technological developments and changes in user requirements are key factors impacting the effective life of an asset.

Estimating life-cycle costs

The life-cycle cost of an asset can be expressed by the simple formula:

$$\begin{aligned} \text{LCC} = & \text{capital cost} + \text{life-time operating costs} \\ & + \text{life-time maintenance costs} \\ & + \text{disposal cost} \\ & - \text{residual value.} \end{aligned}$$

However, ascertaining a measure of each variable in the formula can be difficult. Future costs are usually subject to a level of uncertainty that arises from a variety of factors, including:

- the prediction of the pattern of use of the asset over time;
- the nature and scale of operating costs;
- the need for and cost of maintenance activities;
- the impact of inflation on individual and aggregate costs;
- the prediction of the length of the asset's useful life; and
- the significance of future expenditure compared with present day expenditure.

The longer the period involved, the more difficult it is to estimate future costs. The reality, however, is that it is often unnecessary, at the outset, to estimate costs beyond 15-20 years. In fact, many items of equipment have a useful life of less than 20 years. Even for items with very long lives, the process of discounting future costs means that the costs beyond 20 years generally have only a small impact on the LCC model.

Calculation of life-cycle costs can be assisted by the use of cost models that use sophisticated algorithms to reflect the impact of different assumptions. These models are normally implemented, as computer programs, which enable many different scenarios to be investigated without adding significantly to the time and effort. With these models, a manager can focus on the implications of the analysis for decision-making rather than just on the process of calculating the costs.

Cost elements

To estimate the total life-cycle costs of an asset, it is necessary to identify the key cost elements. The choice of an appropriate set of elements will reflect three specific issues:

1. The element must be a clearly defined activity that generates costs.
 - As far as possible, elements should be independent.
2. The time line for the element's costs must be known.
 - The significance of a cost generally depends on its position in time within the life of the asset.
3. The relationship between the resources used by the element and the resulting cost must be known.
 - Changes in market conditions and price movements are more easily reflected through cost changes in specific resource types.

AS/NZS 4536 recommends a three-dimensional matrix approach to identifying the cost elements to provide a systematic and orderly method of ensuring that all relevant cost elements have been included. The matrix recognises the three issues described above.

The choice of the cost elements for a particular asset should also reflect the complexity of the asset and its key cost drivers. A cost driver is an aspect of the asset that has a direct, significant impact on the scale of costs associated with the creation, use or disposal of the asset. The following examples illustrate some of the cost drivers for a particular asset.

Photocopiers and printers

- method of operation (laser, bubble jet, heat transfer) affects capital cost;
- the type and frequency of replacement of consumable items such as toner cartridges; and
- energy consumption.

Plant and vehicles

- function of vehicle;
- engine capacity and type;
- driving mechanisms;
- fuel type and consumption; and
- wheel and tyre types.

Buildings

- location/land;
- stormwater and sewerage services;
- main structure, roof and external fabric;
- interior fitout, doors and windows;
- building services, including electrical supply, lighting, heating, ventilation and air conditioning;
- energy source and consumption rate charges;
- water supply, internal plumbing and sanitary fixtures;
- security, data and communication systems;
- furnishings and furniture;
- surrounding landscaping;
- carpark and driveway;
- local authority services and charges.

The process of modelling the life-cycle cost of an asset does not make any allowance for depreciation charges that are part of an organisation's profit and loss statement because the full capital cost is already included in the model. If depreciation were also included this would effectively be double counting the capital costs.

Discounting future costs (net present value)

When an organisation has a choice of incurring a cost now or in the future, it generally considers the benefits of alternative uses for the available funds and the cost of raising the necessary funds. Future costs are regarded as less significant because they have the potential to be funded by effective use of existing funds over the intervening period.

For example, if a \$100 purchase is to be made today, it is necessary to have \$100 available now. However, if the purchase can occur in three years' time for \$100, it would be possible to generate the required \$100 by investing \$75.10 at an interest rate of 10% for the three years. If the funds can be used in some other way by the organisation, it may be able to generate more than 10% per year, which would makes the future cost even more attractive.

In a similar way the value of a payment to be received at a future time is regarded as less than the value of receiving it now.

In order to quantify the time impact on future receipts and costs, these cash flows are converted to an equivalent present value. This conversion is based on an estimated discount rate (r) and uses the following formula:

$$\text{Present Value} = \text{FV}/(1+r)^n$$

where **FV** the amount to be spent or received at a point in the future;
n the number of intervals between the present and the future transaction (eg years);
r the discount rate applicable to the chosen intervals; and
^ raised to the power nominated.

For example, an expense of \$100 in three years' time with a discount rate of 10% would have a present value (PV) of:

$$\begin{aligned} \text{PV} &= 100/(1+.1)^3 \\ &= 100/1.331 \\ &= \$75.10 \end{aligned}$$

The **net present value (NPV)** is simply the difference between the present value of future revenue and the present value of future costs for an activity over a given period.

The arithmetic process for calculating present value and net present value is simple and is often available as a specific function on calculators and in computer programs. However, the real difficulty arises in choosing an appropriate discount rate.

The discount rate is usually chosen to reflect the risk-adjusted rate of return on the asset employed to justify the long-term retention of the asset by the entity. One option is to use a rate equivalent to the prevailing basic low-risk interest rate, with a small risk premium for low-risk assets. However, an organisation that is expected to achieve a better return on its funds than this base rate would of course choose a higher rate.

See Chapter 5 'Setting discount rates' in the Department of Finance publication *Handbook of Cost-Benefit Analysis*, AGPS 1991. The Department of Finance and Administration can provide agencies with advice on an appropriate discount rate for significant purchases.

Benefits available from LCC

The information generated by a life-cycle cost analysis can assist managers at various stages in the life of an asset:

- planning and analysis of alternative solutions;
- selection of preferred options;
- securing funding; and
- review of predicted and actual outcomes.

Planning and analysis

The best opportunities to achieve significant cost benefits occur during the early concept development and design phase of any project. At this time, significant changes can be made for the least cost. At later stages of the project many costs have become *locked in*. To achieve the maximum benefit available during this stage of the project it is important to explore:

- a range of alternative solutions;
- the cost drivers for each alternative;
- the time period for which the asset will be required;
- the level and frequency of usage;
- the maintenance and/or operating arrangements and costs; and
- quantification of future cash flows.

The concept of the life cycle of an asset provides a framework to document and compare alternatives.

Selection of preferred option

When a life-cycle cost analysis has been prepared for each option under consideration, it is possible to:

- calculate the NPV of each option;
- consider projected cash flows in the context of the funding available; and
- identify issues related to the ultimate disposal of the asset.

This information can be used by decision-makers as part of the selection process in conjunction with any other operational or policy constraints.

Securing funding

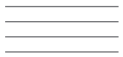
The application of the NPV technique for comparing options that have different cash flow patterns over time is important, but there may also be corporate cash flow issues that need to be considered. There will always be competing demands for the available cash resources at any given time. Management of cash flow is simplified if the pattern is predictable over the long term. The life cycle analysis provides a sound basis for projecting cash requirements, which can assist in a group securing approval for a particular project.

Review

The credibility of future life-cycle plans can be enhanced by systematic collection of historical data related to previous projects. A comparison of projected life-cycle costs with those that actually occur can provide:

- confirmation of the reliability of the life-cycle model;
- information to improve future similar life-cycle models; and
- an appreciation of the risks associated with the various assumptions.

A well documented LCC process justifying a higher initial cost offset by lower long-term costs provides clear evidence for consideration during any review or audit process. In the APS context, it also provides a useful record of the rationale for the decision, which will be valuable to help a new manager understand the reasons for a decision taken by others.



Using Life-cycle Costing

When should it be used?

There are broadly three stages at which LCC should be applied. These are:

- the conceptual stage, when initial proposals for investment are being considered;
- the acquisition stage, when tenders for the supply of equipment, facilities or software are being assessed; and
- the in-service stage, when decisions are being made on whether to maintain, improve or dispose of the asset.

Conceptual stage

LCC at the conceptual stage of a project potentially provides the greatest return for effort. The emphasis here should be on getting at least initial estimates for all the key components of life-cycle costs organised consistently so as to ensure a fair comparison between alternatives.

A major purpose of LCC at this stage is to estimate the pattern of future costs over the life of the asset, enabling provision to be made in future budgets for the cost of acquisition, operation, refit and support. The LCC information can also be used to make cost-performance trade-offs before an acquisition approach is finalised.

Acquisition stage

The emphasis here is on using LCC to help select the most cost-effective option or offer. The LCC analysis can also form part of a tender evaluation process, using:

- a preliminary model of the asset and its environment;
- identification of the potential acquisition cost and major influences on support cost; and
- consideration of the means of constraining these costs.

Where the purchase involves equipment of new design, there should be a contractual provision enabling the purchaser to be assured that the designer has taken into account key LCC parameters such as reliability, maintainability and availability in the design of the equipment. There should be similar provisions relating to the use of LCC in the design of logistic support infrastructure. There



may be scope to have tenderers' assertions relating to reliability and life-cycle costs translated into contractual commitments.⁵

In-service stage

A good knowledge of the actual operating costs of an in-service asset is important not only for improving the cost-effectiveness of the asset in question, but also to improve the specification of future assets. Given the dispersed nature of many agencies, it needs to be made clear at the outset which person or group is responsible for recording in-service costs over an asset's life.

Having a comprehensive and readily useable data base of life-cycle costs enables decisions on changes to the asset and revisions to maintenance policy to be made with the assurance that the cost implications of these changes are well founded. Calculating the LCC impact of a configuration change can be made easier by establishing cost relationships that indicate the cost variations contingent on factors such as weight, power consumption, reliability and time to remove failed components. Further, the ability to identify those components and features generating high costs in systems currently in use can help to drive improvements that lead to cost reductions, and enable better budgeting for future expenditure.

A comprehensive database will also allow tracking of costs as they vary (normally increase) with system age. This will provide information to assist decisions on whether to:

- continue as is;
- initiate modification to the asset to avoid increasing costs; or
- retire the asset and recycle or dispose of its elements.

The APS context

As indicated earlier, the *Commonwealth Procurement Guidelines*, which Commonwealth officials must have regard to, state that the core principle governing Commonwealth procurement is value for money, a concept evaluated on a whole of life basis of the goods or services being procured.

The Purchasing Australia publication on whole of life costing⁶ also underlines the Commonwealth Government's expectation that the full cost of acquiring and operating an asset will be considered in any purchasing decision.

In order to make an appropriate choice between alternative proposals, it is essential to consider not only the immediate costs but also those that will occur during the life of the asset. The LCC techniques provide a sound basis on which to make such whole-of-life comparisons and also supports the review and audit of the acquisition process.

5 The parliamentary Joint Committee of Public Accounts and Audit indicated its support for such a proposal. See JCPAA Report 370 *Defence life cycle costing - Review of Auditor-General's Reports 1997-98 Fourth Quarter*, November 1999, pp10 and 12.

6 Purchasing Australia *Whole of Life Costing in the Assessment of Value for Money*, 1996.

Applying LCC

LCC analysis should begin by developing a plan that addresses the purpose and scope of the analysis. The plan should be to:

- define the objectives;
- identify the cost drivers and establish their parameters;
- apply the formula, and choose the appropriate discount rate; and
- analyse the results.

Defining objectives

Before commencing a LCC analysis, it is important to define the expected outputs and outcomes from the study. Clear outputs ensure that the scope of the study is appropriate and the data is collected at the required level of detail.

The effort applied to defining outcomes should reflect the significance of the asset under consideration. A broad framework for setting required outputs and outcomes follows.

- 1.** Define the analysis objectives, in terms of the outputs that are required to support the management decision.

Typical objectives are:

- determining the life-cycle cost of the asset, to support planning, contracting, budgeting or similar needs;
- evaluating the impact of alternative courses of action (such as design approaches, asset acquisition or support policies or alternative technologies) on the LCC of the asset; and
- identifying cost drivers, to help focus design, development, acquisition or asset support efforts.

- 2.** Delineate the scope of the analysis in terms of:

- the asset options being studied;
- the time period (life cycle phases) to be considered;
- the environment in which the asset will be used; and
- the operating and maintenance support scenario to be employed.

- 3.** Identify any underlying conditions, assumptions, limitations and constraints that might restrict the range of acceptable options to be evaluated (such as minimum performance or availability requirements, or maximum capital cost limitations).

- 4.** Identify alternative courses of action to be evaluated (if this forms part of the analysis objective). In some cases it may be a valid option to continue with the existing situation. The list of proposed alternatives may be refined as new options are identified.

- 5.** 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.



Identifying the cost drivers and establishing their parameters

A key requirement for a successful LCC is the availability of information on the significant cost drivers influencing the life-cycle cost of the alternatives under consideration. Much of this data will come from the designer/manufacturer of major assets and from suppliers of equipment to be acquired.

For example, for items such as plant and equipment, the suppliers should be asked to provide estimates of the:

- initial capital cost of the asset;
- life span of the asset;
- energy consumption per year;
- maintenance costs per year;
- operating resources per year;
- frequency, nature and costs of capital upgrades needed over the life of the asset; and
- cost of disposing of the asset or its components.

The level of detail sought from manufacturers should reflect the scale of the proposed acquisition and the relevance of the data to the life cycle model to be used. There is often significant uncertainty over key long-term parameters such as level of use, impact of new technology, and even on the future functional requirements which makes a detailed analysis inappropriate. A detailed analysis of one aspect may not materially improve the overall analysis.

Applying the formula and choosing a discount rate

The key data used in all life cycle models can be grouped into five main areas, as follows:

- capital cost;
- life-time operating costs;
- life-time maintenance costs;
- life-time asset losses; and
- asset disposal cost.

The LCC model used to manipulate this data may be a simple spreadsheet or a complex computer simulation. However, in every case it is important to use a consistent model for the evaluation of all the alternatives. Use of different models for each alternative approach can make meaningful comparisons very difficult.

Most models generate a cash flow scenario based on current costs and then adjust these values for the impact of cost escalation (including inflation impacts) and a discount factor. The application of cost escalation to the analysis is particularly relevant where:

- the costs of the various elements forming the asset in each scenario are likely to be subject to widely different cost escalation over time; and
- the decision is potentially influenced by the expected cash requirement over time.

Present day costs adjusted for cost escalation are known as "nominal costs".

The choice of discount factor can cause contention among decision-makers using the LCC analysis. The value chosen needs to reflect the policy of the organisation and the nature of the assets employed.

Analysing the results

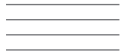
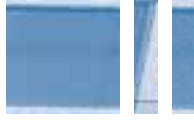
The LCC process is built on a range of assumptions about current and future cash flows and on a range of parameters such as the cost escalation factor(s) and the discount rate. Each element of data has limited accuracy and each potentially has a different impact on the overall analysis outcome. It is therefore important to explore the impact of changes in the values used for key data on the overall results. This type of investigation is known as sensitivity analysis.

Sensitivity analysis can be a manual process for simple life-cycle models or it can be automated in more complex models. Either way, it involves repeating the evaluation of the model for a variety of alternative data values. The values are chosen to reflect the level of uncertainty for the data. For example, if the cost of annual maintenance is estimated at \$125 000 but could range from \$100 000 to \$150 000, it would be appropriate to investigate the effects on the overall analysis of using these three values.

Reporting and recording

The value of LCC analysis is strengthened by presenting the results in a clear consistent format, supported by a summary of the significant assumptions that underpin the model. The following case studies provide simple examples of this documentation.

Listing the cost drivers and assumptions in a comparative table format is often the most appropriate method of presenting and summarising the analysis. The table can then be followed by a list of the key supporting arguments for the selected option.



Case Studies

Considering some practical examples assists understanding of the LCC process. Although each situation requires consideration of the specific circumstances, the broad approach is similar. In the following case studies, there are a number of consistent themes:

- identifying the required function to be delivered (what is the intended purpose of the asset?);
- documenting alternative acquisition and operational strategies;
- investigating and quantifying future costs and income;
- developing a consistent cost model for each option; and
- analysing results in the context of the user/owner business model.

The case studies have been chosen to provide examples of situations that APS managers may face in their business units. In some cases, the material has been simplified to make it more accessible to a range of readers but the key issues remain evident. The case studies present only hypothetical examples of costs and options.

Acquisition of office equipment

A decision to acquire multiple units of office equipment can benefit from LCC. In this case study, a department proposes to acquire several photocopiers. It has identified the following issues and options.

- The photocopy machines will each be required to produce about 3000 copies a month.
- Suppliers offer their machines for purchase or lease.
- The machines will need replacement after five years due to changes in technology and loss of reliability.
- Maintenance is available through a monthly fee related to usage.
- Toner and paper are purchased as needed.

Having considered the technical suitability of the available machines, the department has identified a machine that would meet its needs and has prepared LCC estimates and net present value calculations – see Table 1. The option of contracting out the copying has been included for comparison.

Table 1 – Comparison of photocopier acquisition options, using a discount rate of 10% pa

	Discount Rate	Totals	Year 1	Year 2	Year 3	Year 4	Year 5
	10%	\$					
Option A Outright Purchase							
Income							
Resale value							250
Total income	250	-	-	-	-	-	250
Discounted Income	171	-	-	-	-	-	171
Expenses							
Capital Cost	7 005	7 005					
Copy Charge @ 3000 pm Includes Maintenance	2 145	429	429	429	429	429	429
Toner and consumables	1 695	339	339	339	339	339	339
Internal staff costs – purchasing & support	3 600	720	720	720	720	720	720
Total expenses	14 445	8 493	1 488	1 488	1 488	1 488	1 488
Discounted Expenses	13 210	8 493	1 353	1 230	1 118	1 118	1 016
Net Cost	14 195						
Net Present Value (Cost)	13 039						
Option B Five Year Lease							
Income							
Residual value							1
Total income	1	-	-	-	-	-	1
Discounted Income	1	-	-	-	-	-	1
Expenses							
Lease	8 060	1 612	1 612	1 612	1 612	1 612	1 612
Copy Charge @ 3000 pm Includes Maintenance	2 145	429	429	429	429	429	429
Toner and consumables	1 695	339	339	339	339	339	339
Internal staff costs – purchasing & support	3 600	720	720	720	720	720	720
Total expenses	15 500	3 100	3 100	3 100	3 100	3 100	3 100
Discounted Expenses	12 927	3 100	2 818	2 562	2 329	2 117	
Net Cost	15 499						
Net Present Value (Cost)	12 926						
Option C Contract out							
Price for 3000 pages/month		2 340	2 340	2 340	2 340	2 340	2 340
Internal staff costs – contract management & liaison		1 080	1 080	1 080	1 080	1 080	1 080
Total expense	17 100	3 420	3 420	3 420	3 420	3 420	3 420
Discounted expense	14 261	3 420	3 109	2 826	2 569	2 336	
Net Cost	17 100						
Net Present Value (Cost)	14 261						

Table 1 shows income and costs in current dollars (ie no allowance for inflation) for a single machine using a discount rate of 10%. The Net Present Value (NPV) calculation assumes that the cash flows occur at the start of each period. The calculation could be refined to reflect a different cash flow pattern. This may affect the analysis if the pattern differs between options under consideration.

Table 1 provides information to assist decision making - it does not give the answer. It shows that the lease option (Option B) has the lowest net present value for a 10% discount rate over a five year period.

It is important to consider the impact of the choice of discount rate on the resulting NPV results. Table 2 uses the same basic data for the three options but shows the NPV for different discount rates.

Discount Rate pa	5%	10%	15%
Option A – Purchase (NPV)	13 564	13 039	12 958
Option B – Lease (NPV)	14 092	12 926	11 950
Option C – Contract Out (NPV)	15 547	14 261	13 184

The choice of an appropriate discount rate depends on circumstances relating to ability to raise funds and alternative uses for available funds.

In each case Option C would be the most expensive. The choice between the other two proposals, based on their NPV, will depend on the discount rate selected. For example, with a 5% discount rate the purchase option has the lowest NPV, but at the 10% and 15% rates the lease option has the lowest NPV.

The role of the life cycle analysis is to provide information about the long-term financial implications of a course of action and to assess the impact of the ‘future value of money’.

Renovation or replacement of a building

In this case study, a department’s specialised research unit is adversely affected by problems with its facilities. To overcome the problems, the department has received advice that there are two broad options available – a major renovation of the building or construction of a complete replacement. To assist in evaluating them, LCC information has been prepared – see Table 3.

Table 3 – comparison of building renovation or replacement alternatives, using a discount rate of 10% pa

	Discount rate	Totals	Yr1	Yrs 2 to 11	Yr12	Yr13	Yr14	Yr15
	10%	\$million		(Amount per year)				
Renovation Alternative								
Restoration		4.700	4.7					
Re-roof		0.600			0.6			
Operation & Maintenance		4.500	0.3	0.3	0.3	0.3	0.3	0.3
Less Residual value		0.800						0.8
Totals		9.000	5.0	0.3	0.9	0.3	0.3	-0.5
Present Value		7.210	5.0	Varies by year	0.3	0.1	0.1	-0.1
Replacement Alternative								
Construction		6.500	6.5					
Operation and Maintenance		3.000	0.2	0.2	0.2	0.2	0.2	0.2
Less Residual value		2.000						2.0
Totals		7.500	6.7	0.2	0.2	0.2	0.2	-1.8
Present Value		7.647	6.7	Varies by year	0.1	0.1	0.1	-0.5

The alternatives under consideration will deliver different outcomes but it has been agreed that it will be possible to perform the basic research function under either scenario. The following issues may, however, affect the selection of an appropriate approach.

- To what extent will the efficiency and effectiveness of the research program be affected by the compromises involved in the renovation option?
- Is there a new site available for a new facility or will it be necessary to demolish the existing facility first?
- What changes are likely or possible in the functionality required over the next 15 years?

The impact of various discount rates is shown in Table 4.

Table 4 – Comparison of building renovation and replacement alternatives, using selected discount rates

Discount Rate pa	5%	10%	15%
Renovation (NPV \$million)	7.916	7.210	6.733
Replacement (NPV \$million)	7.670	7.647	7.562



The replacement option, with most of the cost occurring in the first year, becomes less attractive when a higher discount rate is selected. This is consistent with the proposition that expenditure in the future is less financially significant than immediate expenditure, because the money can be used to generate revenue prior to the future outlay. The significance of this effect depends on the potential for the department to use the funds freed by deferring expenditure.

Boiler replacement

This example addresses the situation where there is a trade-off between initial capital cost and ongoing operational and maintenance costs. A department considering whether to replace a hot water boiler has received two proposals. The first involves a low-cost boiler unit with some consequent refurbishment, operation and maintenance and energy cost penalties. The second offers a more expensive unit with claimed savings over the long term.

Table 5 shows the projected costs for each proposal over fifteen years.

Table 5 – Comparison of boiler cost options, using a discount rate of 10% pa

Discount rate	Totals	Yr 1	Yr 2	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	Yr 15
		- 7 (per yr)									
10.0%	(\$000)										
Option A Lower capital cost											
Capital expenditure	50.2	50.2									
Major refurbishment	11.1			2.8		5.5				2.8	
Routine Operation & Maintenance	45.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Energy Costs	15.7	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Totals	122.0	54.2	4.0	6.8	4.0	9.5	4.0	4.0	4.0	6.8	4.0
Present Value	88.6	54.2		3.5	1.9	4.0	1.6	1.4	1.3	2.0	1.1
Option B Higher capital cost											
Capital expenditure	65.0	65.0									
Major refurbishment	7.0							1.5			5.5
Routine Operation & Maintenance	40.5	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Energy Costs	11.3	0.8	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Totals	123.8	68.5	3.5	3.5	3.5	3.5	3.5	5.0	3.5	3.5	9.0
Present Value	95.8	68.5		1.8	1.6	1.5	1.3	1.7	1.1	1.0	2.4

Rounding has been used to arrive at totals

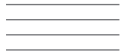
The effect of choosing alternative discount rates is shown in Table 6.

Table 6 – Comparison of boiler cost options, using selected discount rates

Discount Rate pa	5%	10%	15%
Option A – Lower Capital Cost (NPV \$000)	101.3	88.6	80.5
Option B – Higher Capital Cost (NPV \$000)	106.3	95.8	89.3

This analysis indicates that there is no financial advantage in paying the higher initial cost. However, other factors may be critical in the final choice, as follows:

- The lower energy consumption (and cost) may be desirable from a broader environmental perspective.
- The lower cost option will require more frequent refurbishment activity that will disrupt the service provided by the boiler.



Resource Material

Publications

Minister for Finance and Administration *Commonwealth Procurement Guidelines and Best Practice Guidance*, September 2001.

Commonwealth officials must have regard to the Guidelines when purchasing. The Guidelines emphasise value for money in procurement, which should be evaluated on a whole-of-life basis. Available at http://www.finance.gov.au/ctc/publications/purchasing/cpg/commonwealth_procurement_guide.html

Minister for Finance and Administration *Commonwealth Policy Principles for the Use of Private Financing*, October 2001.

These establish policy principles and processes for the use of private financing by Commonwealth departments and agencies. Available at <http://www.finance.gov.au/gf/>

Purchasing Australia – *Whole of Life Costing in the Assessment of Value for Money*, 1996

This easy-to-follow non-technical document provides practical guide on taking acquisition, maintenance, operation and disposal costs into consideration when making purchasing decisions within the APS.

Department of Finance *Handbook of Cost-Benefit Analysis*, AGPS 1991

The Handbook provides detailed guidance on discounting procedures in cost-benefit and cost-effectiveness analysis. (For larger acquisitions, see also the Commonwealth Competitive Neutrality Guidelines for Managers 1998.)

Standards Australia/Standards New Zealand joint standard AS/NZ 4536: Life Cycle Costing – An Application Guide

This Standard details the process of life-cycle costing (LCC) 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 of a product to satisfy an identified need, together with supporting and qualifying documentation.

Definitions and discussions of the various components of LCC are included. The Standard highlights many of the contributing elements for forming a LCC 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 LCC exercises are included, with sample evaluation and presentation proformas.

NPWC Measurement and Cost Planning Committee – *Life Cycle Costing* – Canberra, 1989

This National Public Works Council document relates to LCC as applied to building projects and links energy management, building maintenance management and the collection of cost-in-use data into an integrated system with mutual benefits to designers and building managers.

It outlines the LCC concept and the life-span of building components, explains costs that need to be considered in LCC and discusses discounting methods. Based on the Australian Building Industry at the time (1989), it provides elaborate data on the estimated life, capital costs and cost in use, as well as maintenance, energy and other costs associated with building components. It includes tables of discounted rates calculations and examples of LCC calculations.

Bibliography

American Society for Testing and Materials - E917-99 *Standard Practice for Measuring Life Cycle Costs of Buildings and Building Systems.*

Australian National Audit Office – *Asset Management Handbook* – Canberra, 1996.

Australian National Audit Office – *Audit Report No.43 1997-98 Life-cycle Costing in the Department of Defence* – Canberra 1998.

Joint Committee of Public Accounts and Audit Report 370 *Defence life cycle costing - Review of Auditor-General's Reports 1997-98 Fourth Quarter, November 1999.*

Management Advisory Board/Management Improvement Advisory Committee *Guidelines for Managing Risk in the Australian Public Service 1996.*

National Audit Office (UK) – *Ministry of Defence: Planning for Lifecycle Costs* – London, 1992.

National Committee on Rationalised Building, CSIRO Division of Building - *Building Life Cycle Costs – Guideline* – Melbourne, 1986.

Standards Australia/Standards New Zealand joint standard AS/NZ 4360:1999 *Risk Management.*

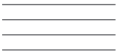
Standards Australia/Standards New Zealand HB143:1999 *Guidelines for managing risk in the Australian and New Zealand public sector.*



Internet resources

There are numerous Internet sites that discuss LCC techniques. Some provide a simple introduction with on-line examples. Others address a specific item of equipment in considerable detail.

Specific sites have not been listed in this guide because of the rapid changes that occur in Internet content but the Internet is a rich source of background information. The best way to find these sites is through search engine.



Glossary

acquisition costs – 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.

life cycle – the time interval between a product's recognition of need or opportunity and its disposal

life-cycle costing – an assessment of design alternatives considering all the significant costs of ownership (NPWC), or an assessment of the cost of a product over its life cycle.

life-cycle cost – the total cost of providing, owning, operating and maintaining a building or component over its useful life (NPWC), or the sum of acquisition cost and ownership cost of a product over its life cycle.

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 products 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.

discounting – the conversion of the value of a cost or benefit at some later point of time to its present value.

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.

discount rate – the indicated rate to be used in the discounting process.

discounted payback period – the number of years required for the present value of benefits to exceed the present value of costs.

net present value (NPV) – the sum of the present values of all benefits less the sum of the present values of all costs.

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.



present value – the value of a cost or benefit in the future, discounted to some base date.

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.

risk management – the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, assessing, treating and monitoring risk.



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