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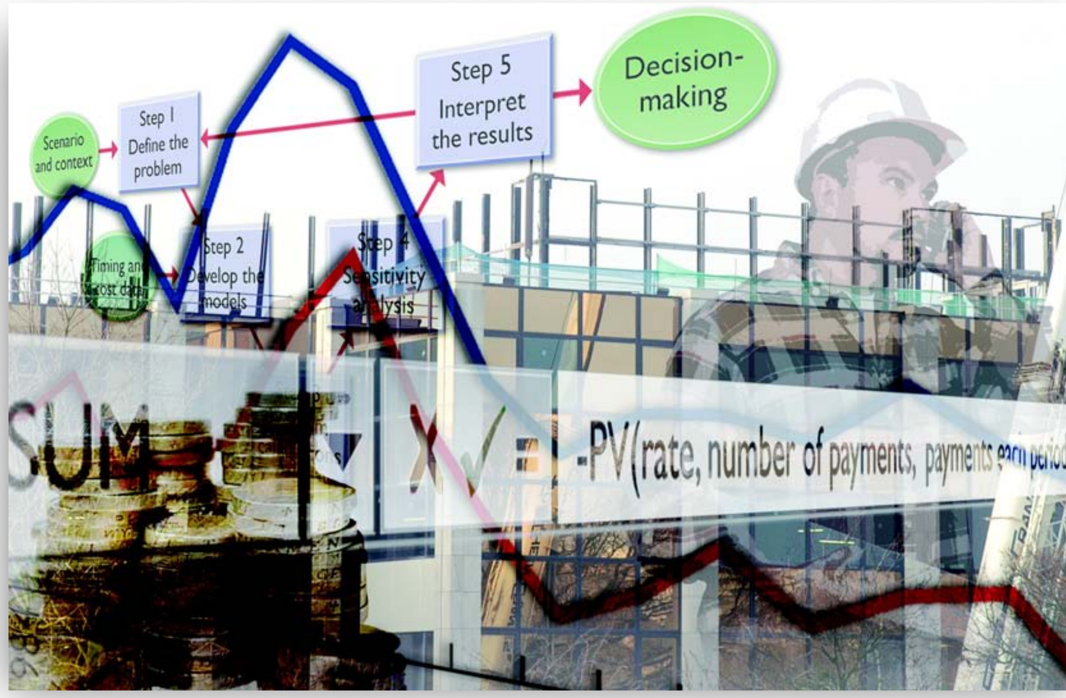
Whole-Life Costing Analysis



By David Churcher

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BG 5/2008

Barry Nealon, Chairman.

The publication of *Whole-Life Costing Analysis* is a very welcome addition to BSRIA's expanding library of guides for those involved in the construction and building services industry.

While the principles of whole-life costing are simple, encouraging us all to consider the ongoing cost of operation, maintenance and disposal, rather than just the upfront price tag, we have traditionally been driven by short-term demands to buy the cheapest.

Whole-life costing is a much more intelligent way of thinking about investments. By taking a longer view we can sow the seeds for a better tomorrow, not only in terms of reducing our operating costs but also in other areas such as reduced energy consumption, reduced environmental impact, reduced maintenance and longer gaps between costly and disruptive replacement projects.

This isn't an exact science and I think you'll find this report reflects and understands that. It will even provide you with some guidance on when it is appropriate to apply the principles and when the potential benefits are outweighed by the cost of the exercise. However, using the whole-life costing principles correctly in the right circumstances should improve your decision-making.

Reliance Facilities Management embraces the concept of whole-life costing. Whether you are new to the subject or are brushing up on best practice, I hope you find this publication a welcome addition to your knowledge.

Barry Nealon
Chairman
Reliance Facilities Management

ACKNOWLEDGEMENTS

BSRIA is grateful to John Langmaid of ACDP (Integrated Building Services) for developing BSRIA's original guidance on whole-life costing, and his valuable assistance and comments during the preparation of this guide.

BSRIA also acknowledges the support of Reliance Facilities Management Services.

This guide is written by BSRIA's David Churcher and designed and produced by Ruth Radburn, BSRIA, 2008.

May 2008 ISBN 978 0 86022 676 5 Printed by ImageData Ltd.

SUMMARY

This guide has been prepared by BSRIA to complement existing knowledge of whole-life costing, and training courses provided by BSRIA. These theoretical and practical training courses are intended to help engineers, architects, facilities managers and clients understand the mechanics of calculating whole-life costs. The draft forerunner to this guide was also developed by John Langmaid and has been issued to delegates attending the BSRIA training courses.

The analysis of whole-life costs is something that we all do in our everyday lives. Its principles help us decide whether to replace our car as the servicing and MOT costs grow in relation to its trade-in value, or whether to buy a cheap and cheerful dishwasher instead of a premium brand that we hope will last longer. In these circumstances we do not go through the process in a systematic, step-by-step way as we work on the basis that our intuition is good enough. However, business decisions can be much more significant, involving larger sums of money and longer timescales.

There is also the issue of good stewardship of corporate or public resources to be considered. For these reasons, more emphasis is being placed on whole-life costing analysis as part of the decision-making process for new-build, refurbishment and plant replacement projects so that all the costs – not just the initial capital investment – can be taken into account.

This guide presents a simple process for the practical calculation of whole-life costs, with examples to show how the different stages of the process relate to one another, to show how the results are obtained and what they mean. Of course, whole-life costing analysis is only one form of project appraisal, focusing on the economic outcome. Ultimately, a decision will be a compromise between this and other assessments, be they technical, environmental or political, but these are outside the scope of this guide.

This guide has been deliberately kept short by omitting some of the more complex aspects of whole-life costing. Clients, estates managers, engineers, consultants, quantity surveyors or cost advisers will find some parts of the guide more relevant than others, but all are recommended to read the entire guidance.

Whole-life costing analysis is just one of a number of assessment techniques that help identify the appropriate solution to a problem. It focuses on economic assessment using profiles of current and future costs and benefits to arrive at a discounted net present value of the whole-life costs, incorporating lump-sum investments, operating costs, end of life costs, and end of study benefits such as residual value.

Although the whole-life costs calculated during the analysis can be presented to any number of decimal places this is not necessarily appropriate. The users of the results must be made aware of the level of confidence that the analysts have in the whole-life costs. Cynics may say that whole-life costs are nothing more than educated guesses.

BSRIA's view, in line with that of HM Treasury, the Office of Government Commerce and a wide range of academic and practitioner commentators, is that this is actually a marked improvement on making significant decisions based on uneducated guesses or gut instinct.

In addition, the whole-life costing process forces the client and the project team to challenge their own assumptions and those of others. This will lead to proposed solutions that have been thought through more rigorously and which will stand up to scrutiny. The discipline of documenting assumptions such as sources of life expectancy and cost data will significantly assist those who need to examine the analysis at some future date. The data that is acquired for the whole-life costing models will also contribute to a building or estate-specific database that can be re-used in future analyses.

Finally, it is worth considering that the whole-life costing analysis requires time and effort to complete. The overhead of carrying out the analysis must always be considered in relation to the potential savings that emerge from the modelling and calculations.

David Churcher
BSRIA, April 2008

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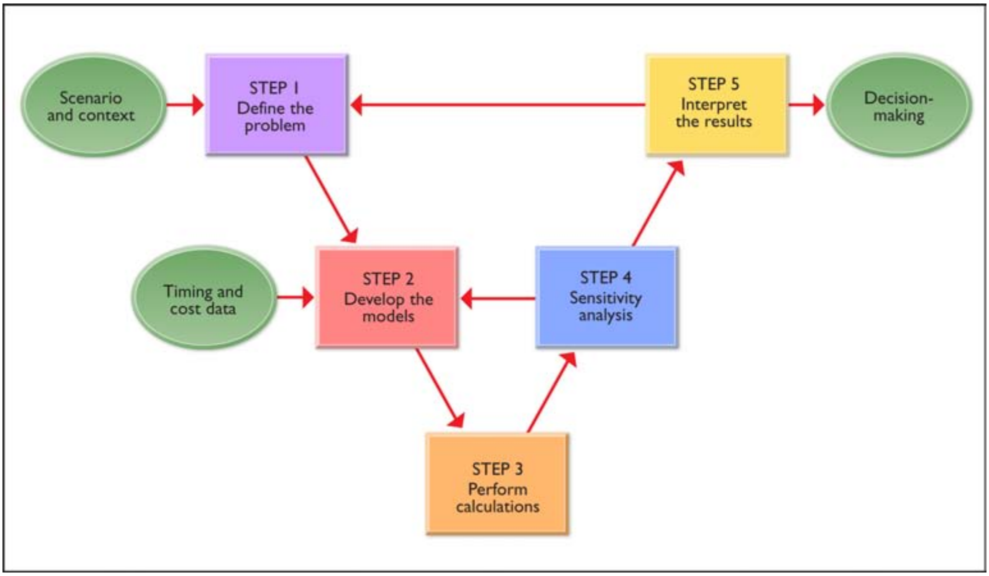
This guide presents a practical approach to whole-life costing analysis for the construction and operation of buildings. A detailed example is used throughout to illustrate the principles as they are discussed. Other publications use the terms life-cycle costing or life-cycle analysis. These terms are more or less interchangeable, but for consistency BSRIA refers only to whole-life costing analysis.

HOW TO USE THIS GUIDE

For ease of use, the process of whole-life costing analysis is broken down into five sequential, colour-coded logical steps that are used throughout this guide. These are illustrated in Figure 1 (other guides to whole-life costing may use different numbers of steps, but the overall process is the same). As the figure also shows, whole-life costing analysis is an iterative process. The number of iterations will depend on the degree of precision required from the end result, the type of assumptions made in Steps 1 and 2, and the quality of the data obtained for the costs and timings of the activities that make up the project.

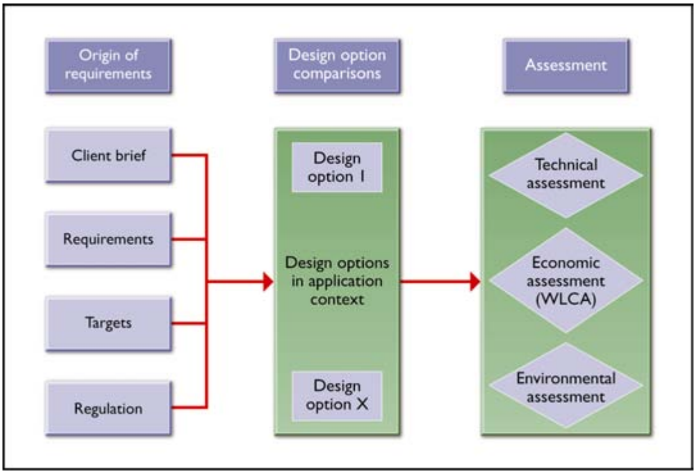
STEP 1	Define the problem
STEP 2	Develop the models
STEP 3	Perform calculations
STEP 4	Sensitivity analysis
STEP 5	Interpret the results

Figure 1: The step-by-step process for whole-life costing analysis.



Whole-life costing analysis is about providing an economic appraisal of different solutions to a given problem, so that a better decision can be made. Of course there are other assessments that also have to be taken into account, as shown in Figure 2, (based on *BS15686*). The final decision will be a compromise between the recommendations desired from the different assessments.

Figure 2: Assessments required for project decision-making.



This guide explains why whole-life costing analysis is particularly important, sets out when it can and cannot be used, and concludes with guidance on defining the problem (Step 1 from Figure 1). Subsequent sections of the guide explain each step in the whole-life costing analysis process in turn.

IMPORTANCE OF WHOLE-LIFE COSTING

It is important that the underlying arguments supporting whole-life costing analysis, its core principles and the restrictions on how it can be used, are understood by everyone involved in scoping, designing and delivering the project.

THE LONG TERM PICTURE OF BUILDING OWNERSHIP

The built environment is a key ingredient in the UK's post-industrial economy. It is a visible statement of our achievement and progress. This applies both where the built environment is the means to an end, as in existing factories, warehouses and office buildings, or whether it is the end in itself, as in new-build and refurbishment work that generates 8-10% of GDP and employment for 2 million people in the UK.

The longevity of the built environment, and of the organisations that use it, means that its cost cannot be judged just in terms of capital investment. The operational costs of construction and infrastructure are significant and have to be taken into account. The precise nature of the balance between construction cost, operation and maintenance costs, and the costs of the business processes enclosed in a building, have been argued in the papers published by the Royal Academy of Engineering *The Long Term Costs of Owning and Using Buildings*, and by Hughes, Ancell, Gruneberg and Hirst, *Exposing the Myth of the 1:5:200 Ratio Relating Initial Cost.* The most important message is that these different types of cost and benefits, traditionally managed by separate groups of people, are not independent of each other. They all contribute to the economic value of a project.

The case for higher capital investment in return for lower running costs or improved worker productivity is there to be argued. Whole-life costing analysis is one of the tools that can be used to support decision-making that takes account of the long-term view of the costs and benefits involved in building and infrastructure projects. Some other relevant assessments are shown in Figure 2.

In our own lives, we find no difficulty in balancing a higher capital investment with a reduced operating cost or a higher resulting value – these are the judgements we make when justifying the purchase of low-energy lamps, loft insulation, or a new car with a higher resale value or greater fuel efficiency. Why then, should organisations find it so difficult to apply the same rational approach to their investments in buildings and plant?

Part of this is due to the much greater complexity of the projects, together with the fact that organisations break down complexity by dividing up roles and responsibilities, to the extent that they fail to see the big picture. Another issue is the difficulty of obtaining data with which to calculate whole-life costs. A third part may be a perception that very precise results are required if these are not available then it's better not to bother at all.

This guide shows how these issues can be overcome or dealt with, and the ways in which whole-life costing analysis can provide valuable information for appraising projects.

THE CORE PRINCIPLES OF WHOLE-LIFE COSTING ANALYSIS

Whole-life costing analysis involves a number of core principles. If, for whatever reason, it is decided that these principles are not appropriate for a project, then whole-life costing analysis is not an appropriate tool to help decision-making.

Comparison not prediction

Whole-life costing analysis is designed to compare the economics of alternative solutions to a specific problem. It is not designed to predict what the actual future costs will be. This is because whole-life costing analysis uses discounting to convert future costs and benefits into a value today. The amounts calculated in the analysis are, not therefore, the same as the actual payments that will need to be made in future years.

Ignore common factors that occur in each alternative solution

This follows from the previous principle. As whole-life costing analysis is about comparison, then any item of cost or benefit that is identical across all the options being compared can be ignored. It has the same effect in each case. In the days when whole-life costs were calculated by hand, this gave valuable savings in both time and opportunity for error.

But since whole-life costs are usually calculated in computer spreadsheets, this is less important.

The opportunity cost of money

This is the jam today principle. This principle means that cash available now has a greater value than the same quantity of money in the future. Whole-life costing analysis uses the principle of discounting to convert money in the future (whether paid or received) into present day money, by applying a discount factor to future payments and receipts. The discount factor depends on how far into the future the payment or receipt is made, and the discount rate that is applied. The selection of a discount rate is explained further in Section 2.2.

Stick to the study period

This is the don't look back principle. This principle means that any costs or benefits that occurred in the past are ignored – the past cannot be undone and money that has already been spent cannot be recovered. Similarly, any costs and benefits that occur after the study period are also ignored. For this reason, study periods have to be chosen with care and the reasons for choosing them have to be clearly stated. This is also covered in more detail in Section 2.2.

Whole-life costing analysis is a quantitative process

This is the 'garbage in, garbage out' principle. This principle means that the value of the numerical results obtained from the modelling and calculation procedures is directly related to the precision and accuracy of the data that is fed into the models. Two types of data are required: data about the cost of individual activities and components that make up the projects; and data about the timing of future events. The latter is mainly concerned with the life expectancies of building components or items of plant and machinery.

The future occurs in finite blocks of time

This principle means that the study period is divided into time periods, typically years. Costs and benefits that occur within any one year are all treated as though they happened at the same time, at the end of the year (*The Green Book*, published by HM Treasury, uses mid-year rather than end-of-year, but the effect is exactly the same). If this sub-division is too coarse for your project, you can use months or weeks instead, provided the discount rate is expressed in similar terms (x% per month or week).

Summary

Whole-life costing analysis is about being approximately right rather than precisely wrong. These principles also mean that whole-life costing analysis is not a trivial exercise, and it can take significant resources to build the models, assemble the data, run and fine-tune the calculations. Of course it is sensible to keep the amount being spent on the analysis under review, particularly in comparison with the potential savings.

WHAT WHOLE-LIFE COSTING ANALYSIS CAN DO

Make economic judgements between alternative technical solutions
This is the most usual application of whole-life costing analysis. This uses a golden rule – the option with the lowest whole-life cost is the preferred solution. Many clients have fallen into the trap of believing that the lowest capital cost is the most economically advantageous solution, but this is often not the case and is one reason why whole-life costing analysis is becoming more and more widely used. Neither can it be assumed that higher capital costs automatically lead to lower operating costs.

Convert whole-life costs into equivalent annual costs
Whole-life costs are given as a single figure for each solution over a whole study period with reference to the discount rate (for example, the whole-life cost of Option A is £123 456 over 15 years at 3·5% discount rate). However, the same whole-life cost can be expressed in equivalent annual terms, using the appropriate factor (the equivalent annual cost of Option A is £10 716 per year for 15 years at 3·5%). Care must be taken in these cases not to confuse the equivalent annual cost with a quotation for a budget figure.

Judge the economic worth of independent projects
If a budget holder has proposals for several independent projects, then whole-life costing analysis can help decide the order in which projects should be given the go-ahead to guarantee the maximum level of savings in operation, maintenance and repair costs.

WHAT WHOLE-LIFE COSTING ANALYSIS CANNOT DO

Define future budgets for capital and revenue works
Whole-life cost analysis will not calculate the actual amounts of expenditure in future years, but the data collected as part of whole-life cost analysis can be used to generate these future budget amounts.

Take account of non-monetary costs and benefits
Whole-life cost analysis can only take account of factors that can be expressed in monetary terms. Anything else (for example, better community relations from a renewable energy installation) has to be included in a different kind of assessment (see Figure 2).

Compare alternatives that do not produce the same technical outputs
Whole-life cost analysis assumes that the different alternative solutions have the same functionality; for example, that alternative heating systems produce the same levels of comfort, or that alternative office buildings house the same numbers of staff. If this is not the case then the whole-life cost analysis is not valid unless the difference can be quantified and allowed for.

The first steps of whole-life costing analysis require a thorough definition of the problem to be analysed. Time spent here, in preparation for the next stage of constructing the whole-life costing models, will avoid wasted effort and rework later.

Someone, usually the client or project sponsor, will have a clear idea of what they want the project to achieve. This vision of success needs to be expressed in functional terms. This means describing the problem in terms of what the end-result has to achieve rather than what it looks like, what size it is, what colour it is, who manufactures it, and so on. For example: "Save 25% of energy costs without disrupting the existing use of the building" (rather than specifying new boilers); or "Accommodate 45 new members of staff" (rather than specifying a two-storey, 500 m^2 office extension).

It is the client's responsibility to make sure that everyone on the project team shares the definition of the project's functional outcome, and it is also the whole team's responsibility to make sure that assumptions are challenged and that the pre-defined boundaries, beyond which they cannot go, are fully understood.

There are many existing techniques to help develop this shared understanding (such as the five-whys, boundary examination/relaxation, and goal orientation), but they are not explained in detail here.

Example of Step 1	**Defining the problem**
Project: Upgrade	At ACME Ltd, the facilities manager expressed concerns at the annual energy and maintenance costs of the company's existing heating and ventilation systems. The facilities manager has been comparing notes with fellow facilities managers who work for other firms with similar sized offices (2000 m^2) and similar patterns of occupancy (weekdays, 07.00 – 19.00 h). ACME's directors have asked the facilities manager to investigate the case for upgrading the systems to provide cost savings for the remainder of their lease, which has 17 years to run. To reach this point, the facilities manager had already collected some data about the systems installed in the building and the operational costs of running and maintaining them. This came from an inspection of the plant, documentation in the operation and maintenance manuals, and collation of the last five years energy bills for gas and electricity.