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Buildings and constructed assets — Service life planning —

Part 5: Life-cycle costing

Bâtiments et biens immobiliers construits — Prévision de la durée de vie —

Partie 5: Approche en coût global

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 59, *Buildings and civil engineering works*, Subcommittee SC 14, *Design life*.

This second edition cancels and replaces the first edition (ISO 15686-5:2008), which has been technically revised.

The main changes compared to the previous edition are as follows:

— several clauses have been technically revised to clarify the distinction between normative content and guidance text;

— Annexes C and D have been technically revised to make them clearer;

— the bibliography has been updated.

A list of all parts in the ISO 15686 series can be found on the ISO website.

Introduction

Objectives

The key objectives of this document are to:

— establish clear terminology and a common methodology for life-cycle costing (LCC);

— enable the practical use of LCC so that it becomes widely used in the construction industry;

— enable the application of LCC techniques and methodology for a wide range of procurement methods;

— help to improve decision making and evaluation processes at relevant stages of any project;

— address concerns over uncertainties and risks and improve the confidence in LCC forecasting;

— make the LCC and the underlying assumptions more transparent and robust;

— set out the guiding principles, instructions and definitions for different forms of LCC and reporting;

— provide the framework for consistent LCC predictions and performance assessment, which facilitates more robust levels of comparative analysis and cost benchmarking;

— provide a common basis for setting LCC targets during design and construction, against which actual cost performance can be tracked and assessed over the asset life span;

— provide guidance on when to undertake LCC, to what level and what cost headings are appropriate for consideration;

— help unlock the real value of effectively doing LCC in construction by using service life planning;

— clarify the differences between life-cycle costing and whole-life costing (WLC);

— provide a generic menu of costs for LCC/WLC compatible with and customizable for specific national or international cost codes and data-structure conventions;

— provide cross-references to guidance on associated activities within the other parts of ISO 15686.

Life-cycle costing, service life planning and other performance requirements

Life-cycle costing is a valuable technique that is used for predicting and assessing the cost performance of constructed assets. Life-cycle costing is one form of analysis for determining whether a project meets the client's performance requirements. Analyses can necessitate the use of other parts of ISO 15686 and current economic data from clients and the construction industry (see Figure 1). It is possible to use this document without extensive reference to others, although a number of the terms and techniques described are covered in more detail in the other parts. Where applicable, this is referenced in the text. The other parts of ISO 15686 that are most relevant for life-cycle costing are ISO 15686-1 and ISO 15686-3.

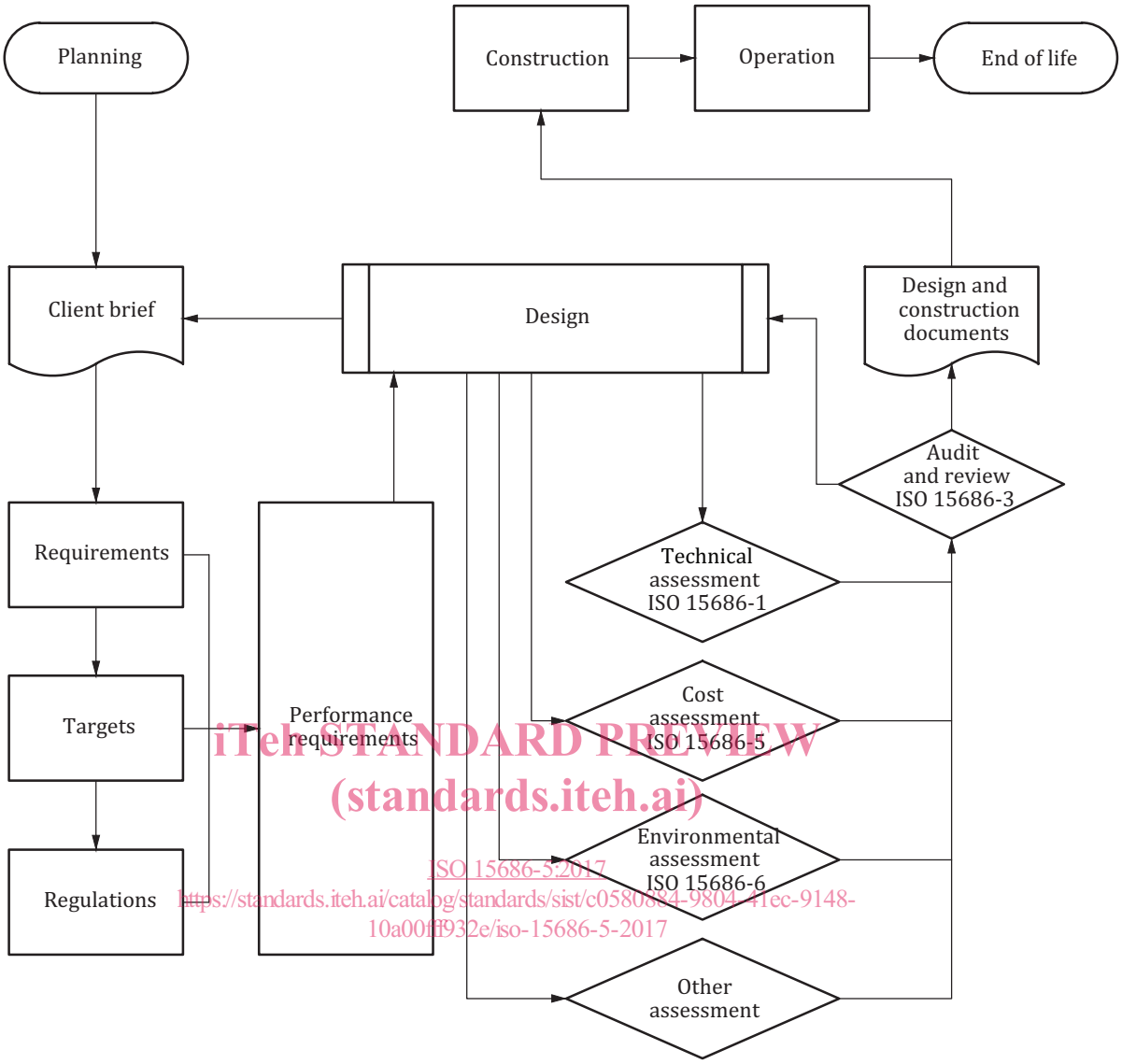

Figure 1 — Performance requirements in the context of the project life cycle

The Bibliography includes some informative national standards and guidance that provide more detail on aspects such as levels of cost analysis, examples of analysis and application of the principles for practical projects.

Who can use this document?

The provisions of this document are intended primarily for:

— procurers of constructed assets, with an interest in long-term ownership; these may be public or private, or lessees with a reasonably long period of interest in the property and/or responsibility for maintenance and/or operational costs;

— designers;

— constructors and their specialist suppliers of materials and components;

— facility operators (to help them input more effectively into the design process);

— cost consultants and other specialists.

The provisions in this document are particularly relevant to public clients, where the lack of any projected income from some constructed assets can make traditional investment appraisals more challenging. They are also relevant to the work of specialists providing information on service life and on environmental performance.

The period of interest of the client and the contractual responsibilities/liabilities for meeting costs tend to determine the requirements for life-cycle costing.

Life-cycle costing is relevant at portfolio/estate management, constructed asset and facility management levels, primarily to inform decision-making and for comparing alternatives. Life-cycle costing allows consistent comparisons to be performed between alternatives with different cash flows and different time frames. The analysis takes into account relevant factors from throughout the service life, with regard to the client's specified brief and the project-specific service life performance requirements.

Buildings and constructed assets — Service life planning —

Part 5:
Life-cycle costing

1 Scope

This document provides requirements and guidelines for performing life-cycle cost (LCC) analyses of buildings and constructed assets and their parts, whether new or existing.

NOTE 1 Life-cycle costing takes into account cost or cash flows, i.e. relevant costs (and income and externalities if included in the agreed scope) arising from acquisition through operation to disposal.

NOTE 2 Life-cycle costing typically includes a comparison between alternatives or an estimate of future costs at portfolio, project or component level. Life-cycle costing is performed over an agreed period of analysis, clearly identifying whether the analysis is for only part of or for the entire life cycle of the constructed asset.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 6707-1, *Building and civil engineering works — Vocabulary — Part 1: General terms*

ISO/TR 15686-11, *Building and constructed assets — Service life planning — Part 11: Terminology*

ISO Guide 73, *Risk management — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO Guide 73, ISO 6707-1, ISO/TR 15686-11 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at http://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 Costs

3.1.1
acquisition cost
all costs included in acquiring an asset by purchase/lease or construction procurement route, excluding costs during the occupation and use or end-of-life phases of the *life cycle* (3.3.4) of the constructed *asset* (3.4.1)

3.1.2
capital cost
initial construction costs and costs of initial adaptation where these are treated as capital expenditure

Note 1 to entry: The capital cost may be identical to the *acquisition cost* (3.1.1) if initial adaptation costs are not included.

3.1.3
discounted cost
resulting cost when the *real cost* (3.1.12) is discounted by the *real discount rate* (3.3.7) or when the *nominal cost* (3.1.10) is discounted by the *nominal discount rate* (3.3.5)

3.1.4
disposal cost
costs associated with *disposal* (3.4.2) of the *asset* (3.4.1) at the end of its *life cycle* (3.3.4), including taking account of any asset transfer obligations

Note 1 to entry: Asset transfer obligations could include bringing the assets up to a predefined condition.

Note 2 to entry: Income from selling the asset is part of *whole-life costing* (3.1.15), where the *residual value* (3.3.8) of the building, components, materials and appliances can be included.

3.1.5
end-of-life cost
net cost or fee for disposing of an *asset* (3.4.1) at the end of its service life or interest period

Note 1 to entry: End-of-life costs can include costs resulting from decommissioning, deconstruction and demolition of a building, site decontamination/remediation, recycling, recovery, and disposal of components and materials; and transport and regulatory costs.

3.1.6
external costs
costs associated with an asset that are not necessarily reflected in the transaction costs between provider and consumer and that, collectively, are referred to as externalities

Note 1 to entry: These costs may include business staffing, productivity and user costs; these can be taken into account in a life-cycle cost analysis but are to be explicitly identified.

3.1.7
life-cycle cost
LCC
cost of an *asset* (3.4.1) or its parts throughout its *life cycle* (3.3.4), while fulfilling the performance requirements

3.1.8
life-cycle costing
methodology for systematic economic evaluation of *life-cycle costs* (3.1.7) over a period of analysis, as defined in the agreed scope

Note 1 to entry: Life-cycle costing can address a period of analysis that covers the entire life cycle or (a) selected stage(s) or periods of interest thereof.

3.1.9
maintenance cost
total of necessarily incurred labour, material and other related costs incurred to retain a building or its parts in a state in which it can perform its required functions

Note 1 to entry: Maintenance includes conducting corrective, responsive and preventative maintenance on constructed assets, or their parts, and includes all associated management, cleaning, servicing, repainting, repairing and replacing of parts, where needed, to allow the constructed asset to be used for its intended purposes.

3.1.10
nominal cost
expected price that will be paid when a cost is due to be paid, including estimated changes in price due to, for example, forecast change in efficiency, inflation or deflation and technology

3.1.11
operation cost
costs incurred in running and managing the facility or built environment, including administration support services

Note 1 to entry: Operation costs could include rent, rates, insurances, energy and other environmental/regulatory inspection costs, local taxes and charges.

3.1.12
real cost
cost expressed as a value at the base date, including estimated changes in price due to forecast changes in efficiency and technology, but excluding general price inflation or deflation

3.1.13
sunk costs
costs of goods and services already incurred and/or irrevocably committed

Note 1 to entry: These are ignored in an appraisal. The opportunity costs of obtaining or continuing to tie up capital are, however, included in *whole-life cost* (3.1.14) analysis and the opportunity costs of using *assets* (3.4.1) can be dealt with as costs in *life-cycle cost* (3.1.7) analysis.

3.1.14
whole-life cost
WLC
all significant and relevant initial and future costs and benefits of an *asset* (3.4.1), throughout its *life cycle* (3.3.4), while fulfilling the performance requirements

3.1.15
whole-life costing
methodology for systematic economic consideration of all *whole-life costs* (3.1.14) and benefits over a period of analysis, as defined in the agreed scope

Note 1 to entry: The projected costs or benefits may include external costs (including, for example, finance, business costs, income from land sale, user costs).

Note 2 to entry: Whole-life costing can address a period of analysis that covers the entire life cycle or (a) selected stage(s) or periods of interest thereof.

Note 3 to entry: This definition is to be contrasted with that for *life-cycle costing* (3.1.8).

3.2 Analysis/measures

3.2.1
life-cycle assessment
LCA
method of measuring and evaluating the environmental impacts associated with a product, system or activity, by describing and assessing the energy and materials used and released to the environment over the *life cycle* (3.3.4)

3.2.2
net present value
NPV
sum of the discounted future cash flows

Note 1 to entry: Where only costs are included, this can be termed *net present cost* (3.2.3).

Note 2 to entry: This is the standard criterion for deciding whether an alternative can be justified on economic principles, but other techniques are also used as described in Annex B.

3.2.3
net present cost
NPC
sum of the discounted future costs

3.2.4
present-day value
PDV
monies accruing in the future which have been discounted to account for the fact that they are worth less at the time of calculation

3.2.5
sensitivity analysis
test of the outcome of an analysis by altering one or more parameters from initial value(s)

3.3 Elements of calculation

3.3.1
discount rate
factor or rate reflecting the *time value of money* (3.4.7) that is used to convert cash flows occurring at different times to a common time

Note 1 to entry: This can be used to convert future values to *present-day values* (3.2.4) and vice versa.

3.3.2
escalation rate
positive or negative factor or rate reflecting an estimate of differential increase/decrease in the general price level for a particular commodity, or group of commodities, or resource

Note 1 to entry: An escalation rate is derived by tracking the change in price over time of a single commodity, group or commodities or resource, which might or might not be one of the items in the typical "basket" of goods that is used to derive a general inflation/deflation factor.

3.3.3
inflation/deflation
sustained increase/decrease in the general price level

Note 1 to entry: Inflation/deflation can be measured monthly, quarterly or annually against a known index.

3.3.4
life cycle
consecutive and interlinked stages of the object under consideration

Note 1 to entry: The life cycle comprises all stages from construction, operation and maintenance to end-of-life, including decommissioning, deconstruction and disposal.

Note 2 to entry: Adapted from the definition of life cycle contained in ISO 14040.

3.3.5
nominal discount rate
factor or rate used to relate present and future money values in comparable terms taking into account the general inflation/deflation rate

3.3.6
period of analysis
period of time over which *life-cycle costs* (3.1.7) or *whole-life costs* (3.1.14) are analysed

Note 1 to entry: The period of analysis is determined by the client.

3.3.7
real discount rate
factor or rate used to relate present and future money values in comparable terms, not taking into account the general or specific inflation in the cost of a particular *asset* (3.4.1) under consideration

3.3.8
residual value
value assigned to an asset at the end of the *period of analysis* (3.3.6)

3.4 Other terms

3.4.1
asset
whole building or structure or unit of construction works, or a system or a component or part thereof

3.4.2
disposal
<end of life> transformation of the state of a building or facility that is no longer of use

Note 1 to entry: Transformation can include, either individually or in some combination, the decommissioning, deconstruction, recycling and demolition of the object of consideration.

3.4.3
disposal
<status change> transfer of ownership of, or responsibility for, the object of consideration

3.4.4
externality
quantifiable cost or benefit that occurs when the actions of organizations and individuals have an effect on people other than themselves

EXAMPLE Non-construction costs, income and wider social and business costs.

Note 1 to entry: Externalities are positive if their effects are benefits to other people and negative, or external costs, if the external effects are costs on other people. There may be external costs and benefits from both production and consumption. Adding the externality to the private cost/benefit gives the total social cost or benefit.

3.4.5
intangible
quantifiable cost and benefit that have been allocated monetary values for calculation purposes

3.4.6
risk
probability of an event multiplied by its consequences

Note 1 to entry: Examples of an event are failure and damage.

Note 2 to entry: Examples of consequences are cost, fatalities and exposure to personal or environmental hazard.

3.4.7
sustainability
state of the global system, including environmental, social and economic aspects, in which the needs of the present are met without compromising the ability of future generations to meet their own needs

Note 1 to entry: The environmental, social and economic aspects interact, are interdependent and are often referred to as the three dimensions of sustainability.

Note 2 to entry: Sustainability is the goal of *sustainable development* (3.4.8).

3.4.8
sustainable development
development that meets the environmental, social and economic needs of the present without compromising the ability of future generations to meet their own needs

Note 1 to entry: Derived from the Brundtland Report.

3.4.9
time value of money
measurement of the difference between future monies and the *present-day value* (3.2.4) of monies

3.4.10
uncertainty
lack of certain, deterministic values for the variable inputs used in a *life-cycle cost* (3.1.7) analysis of an asset

4 Principles of life-cycle costing

4.1 Purpose and scope of life-cycle costing

The purpose of life-cycle costing should be to quantify the life-cycle cost (LCC) for input into a decision-making or evaluation process, and should usually also include inputs from other evaluations (e.g. environmental assessment, design assessment, safety assessment, functionality assessment and regulatory compliance assessment). The quantification should be to the level of detail that is required for key project stages. The scope of costs included/excluded from an LCC analysis should be defined and agreed with the client at the outset.

4.2 Costs to include in LCC analysis

4.2.1 Defining scope of costs included in the analysis

LCC analysis covers a defined list of costs over the physical, technical, economic or functional life of a constructed asset, over a defined period of analysis. Life-cycle costing is influenced by non-construction costs and wider occupancy costs, as well as local, national or international policies, allowances, taxes, etc. LCC analysis may include allowances for foreseeable changes, such as future occupancy levels or changing legislative or regulatory parameters. LCC analysis may also form part of a strategic review of procurement routes or objectives (such as enhancing sustainability or improving functionality).

Practice can vary between users as to whether only costs borne by the customer for the analysis (typically the construction client) are taken into account, or whether customer/societal, etc. costs are also included.

NOTE 1 Where the user and the construction client are different parties (e.g. in social housing), it can be required to take these external costs into account.

The definitions of the terms “intangible” (3.4.3) and “externality” (3.4.2) have been formulated to describe the wider costs. The former are monetized aspects which have some (often indirect) economic impact on the client organization. The latter are external to the client organization. It is necessary that both be clearly identified as such in any analysis. This issue is dealt with in more detail in Clause 7.

Figure 2 indicates graphically the costs that should be included in life-cycle costing and those wider costs and incomes that should be referred to as whole-life costs.

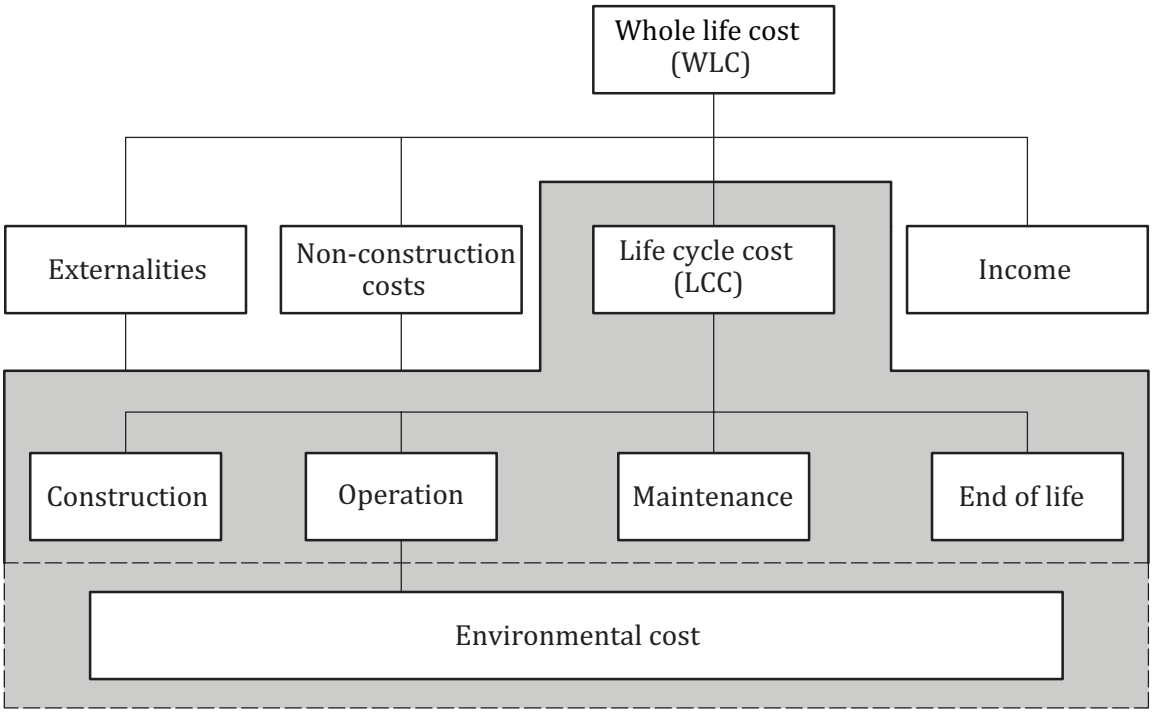

Figure 2 — WLC and LCC elements

The LCC analysis should consider all basic elements, such as the structure, envelope, services and finishes, fixtures and fittings, and the same cost issues for all alternatives appraised.

Environmental cash flows forming part of life cycle costing may be negative (costs, for example, taxes) or positive (incomes, for example, income from renewable energy generation). Since life cycle costing deals generally with costs as positives it is important to ensure that these are shown correctly. Project costs before commencement of design for construction (e.g. feasibility studies) form part of WLCs, not LCCs.

NOTE 2 Monetization of environmental impacts and external impacts are dealt with in 6.3 and 6.5.

4.2.2 Classification of costs

Figure 3 describes a generic cost classification that may be used to help define the specific scope of the analysis, providing a structured basis for comparative analysis that is intended to accommodate local practices.

NOTE 1 It is not necessary for every item included in the figure to be considered, and some additional costs can be required for certain projects. The intention is that more detailed guidance and cost structures applicable to national conditions are used to develop the cost plans, which can then be mapped to this structure.