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Life cycle costing – LCC in Construction

New recommendations and future views

Paljon uutta on tapahtumassa elinkaarikustannusten laskennassa rakennus- ja kiinteistöklusterin alueella. Uusia standardeja, uusi opas EU-jäsenmaille, ja uusia välineitä tulevaisuuden ennustamiseen.

Olavi is Managing Director of Villa Real Ltd/SA, a 15-year-old Finnish engineering and consulting company specialised on sustainable development, and offering a range of services to the international clientele of the Construction and Real Estate Cluster - CREC. As an active member of several working groups in Brussels, Olavi has influentially contributed to various EU-documents on sustainable construction.

What is LCC?

Derived from ISO 15686: **Life Cycle Costing – LCC** is a technique which enables comparative cost assessments to be made over a specified period of time, taking into account all relevant economic factors both in terms of initial capital costs and future operational costs. In particular, it is an economic assessment considering all projected relevant cost flows over a period of analysis expressed in monetary value. Where the term uses initial capital letters it can be defined as the present value – PV of the total cost of an asset over the period of analysis.

Initial capital costs refer to costs directly related to the whole building and its components and assemblies, including planning, design, construction, installation, fees and charges and other acquisition costs. Future operational costs refer to the costs of all different activities necessary to run the building, ie operating, maintenance, repair, refurbishment and disposal, less any residual value. Period of analysis is determined as per the planned or ongoing activity and it can be whatever up to the end of the building's service life.

New ISO standards on LCC and service life in making

Very important standard development is taking place in the newly reorganised ISO[1] technical committee TC59 "Building construction", particularly in its subcommittee SC14 "Design life". The series ISO 15686 "Buildings and constructed assets – Service life planning" is rapidly offering new tools for the life cycle planning of buildings or other constructed assets. So far this series covers eight parts as follows: the first 3 parts are ready and the remaining parts advanced.

- ISO 15686-1 "General Principles" deals with issues and data needed to forecast service lives and gives a method for estimating the service lives of components and assemblies; umbrella standard.

- ISO 15686-2 "Service Life Prediction Principles" describes a generic method for using testing of performance of components and assemblies to provide a service life prediction.
- ISO 15686-3 "Performance audits and reviews" provides tools for audits and reviews to ensure that relevant steps have been taken to achieve a service life that will match or exceed the design life.
- ISO 15686-4 "Data requirements" is a Technical Guide on methods of presenting data and evidence to support forecasts.
- ISO 15686-5 "Life cycle costing" will provide guidance on life cycle costing.
- ISO 15686-6 "Procedure for considering environmental impacts" will provide guidance on assessing environmental sustainability in the context of service life planning.
- ISO 15686-7 "Performance evaluation and feedback of service life data from existing construction works" will provide guidance on how to structure and use feedback data on in-use condition.
- ISO 15686-8 "Reference service lives" provides guidance on assessment of default service lives using available information.

This writer considers this development positive and important. Unfortunately the work done on "Part 5: Life cycle costing" has produced totally confusing, derailed papers in contradiction with the umbrella standard. The confusion lingers about the introduction of Whole Life Cost(ing) – WLC, a British wording, to replace internationally recognised Life Cycle Cost(ing) – LCC (the work is headed by British Standards Institution – BSI). Also the arithmetics used diverts from commonly known and understood formulas. This all is to alienate the prospective users from the new standards.

Finland, as an active participating country, wants the Part 5 rewritten entirely. The Finnish "mirror group" (OT a member), convened by Pekka VUORINEN of the Confederation of Finnish Construction Industries – RT is contributing towards a better standard. Here it is important that Matti J VIRTANEN of the Ministry of Environment has been appointed as one of the seven experts to finalise the paper.

LCC in Construction - a brand new EU guide

In late 2001, a task group TG4 (OT a member) was established by the EC DG Enterprise to "Draw up recommendations and guidelines on Life Cycle Costs – LCC of construction aimed at improving the sustainability of the built environment". The group tries to find models for practical application of sustainable construction based on present value – PV of economic and environmental factors. Societal factors (social, cultural, ethical etc) were unfortunately left out.

The final report "Life cycle costs in Construction"[1] was approved 29.10.2003 in a tripartite meeting in Brussels, comprising representatives from the Commission, member states and industry (OT a member). The paper, to be printed and distributed to all member and candidate states, makes the following recommendations:

- Adopt a common European Methodology for assessing LCC of construction
- Encourage data collection for benchmarks, to support best practice and maintenance manuals
- Public procurement and contract award incorporating LCC
- Life cycle cost(ing) indicators should be displayed in buildings open to public
- Life cycle cost(ing) should be carried out at the early design stage of a project
- Fiscal measures to encourage the use of LCC
- Develop guidance and fact sheets

The guide contains major contribution from this writer plus a 4-page appendix leading to Total LCC, first time introduced in my book "Construction Can!"[2] published by arrangement of ENCORD[2] in 1998, to cover not only the initial capital and future operational costs of a building but also the monetarisation of externalities and intangibles, ie occupational, locational, environmental and societal costs. In the first meeting of TG4 this approach was actually approved. Yet, later it was seen too ambitious, and a more conventional approach was chosen.

This guide discarded WLC as globally unknown, confusing and misleading, and sticks to LCC and commonly used formulas for calculation, as follows.

The Present Value – PV procedure reduces a series of cash flows which occur at different times in the future to a single value at one point in time, the present. The technique which makes this transformation possible is called discounting. LCC is calculated as the PV of accumulated future costs (C) over a specified period of time (t), eg 25 years (N), at an agreed discount rate (d), eg 2% = 0.02 pa, dependant on prevailing interest and inflation rates. NPV is calculated according to the following formula, and can be done with MS Excel (up to 29 years easily...).

$$PV = \sum_{t=0}^{N} \frac{C_t}{(1+d)^t} \qquad (1)$$

PV can be calculated using nominal costs and discount rate based on projected actual future costs to be paid, including general inflation or deflation, and on projected actual future interest rates. Nominal costs are generally appropriate for preparing financial budgets, where the actual monetary amounts are required to ensure that actual amounts are available for payment at the time when they occur.

PV can be calculated also using real costs and discount rate, ie present costs (including forecast changes in efficiency and technology, but excluding general inflation or deflation) and real discount rate (d_{real}), which is calculated according to the following formula, where (i) = interest rate and (a) = general inflation (or deflation) rate, all in absolute values pa.

$$d_{real} = \frac{1+i}{1+a} - 1 \qquad (2)$$

To make the LCC approach significant for improving the sustainability of the built environment and the related calculations easier to understand, real costs and discount rate are useful. Over a long period of time, real discount rate is usually 0…2% pa only. At low discount rates long-term future

costs and savings are meaningful also at present.

Also, it may be claimed that future LCC costs will be increasing due to higher energy prices and new environmental and other regulatory requirements. This development will raise the calculated return and may enable market-driven LCC considerations.

For LCC to become widely accepted, concerns about uncertainties in forecasting should be overcome. The guide refers to a related European RTD project ''EuroLifeForm'', which is to advance a probabilistic approach to LCC in construction, as described here later.

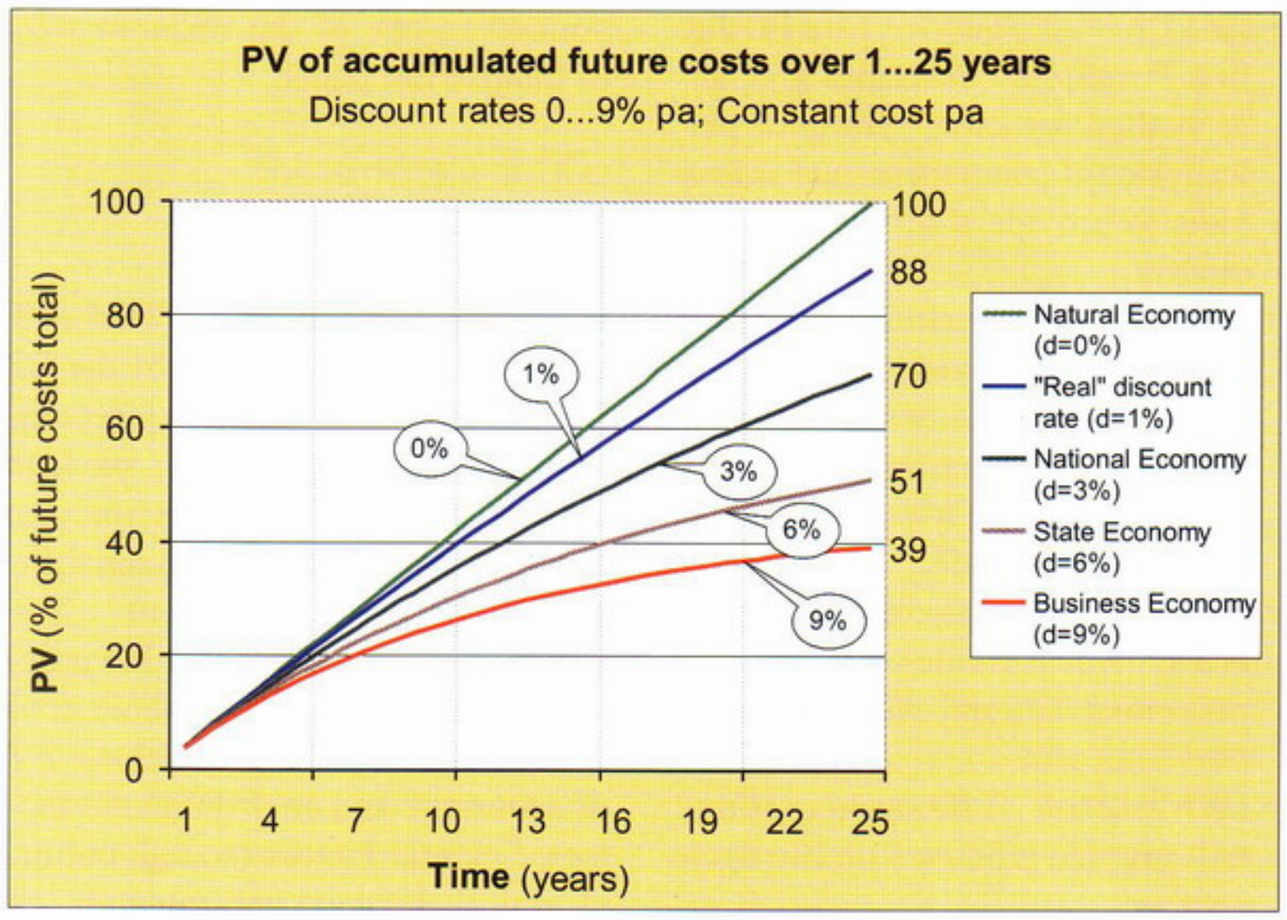

Figure 1. PV of accumulated future costs over 1…25 years.

What discount rates for what economies?

The present value – PV of accumulated future costs depends on the used discount rate(s). In the following chart I introduce four "rooms" of different stakeholders. For each room a certain level of nominal discount rate is applicable. These rooms I descriptively call **Natural** (d=0% = simple payback), **National** (3%), **State** (6%) and **Business** (9%) Economies. The chart shows how PV is accumulating over 1…25 years in each room or economy. In addition, I offer 1% pa as a suitable real discount rate.

The rate of return available through LCC considerations today is lower than that offered by alternative long-term investment: as nominal annual return, stock market 15% (–90% for .coms ⇐ risk), 9% business ROC/ROE (⇐ risk), 6% bonds, 3% bank deposits.

Buildings have long service lives. Because of difficulties in predicting inflation in long term it is recommendable to use real costs and real discount rate. At low discount rates long-term future costs and savings are immediately meaningful, as can be seen in the above figure at 1% rate. Thus investment for a better future looks more rewarding.

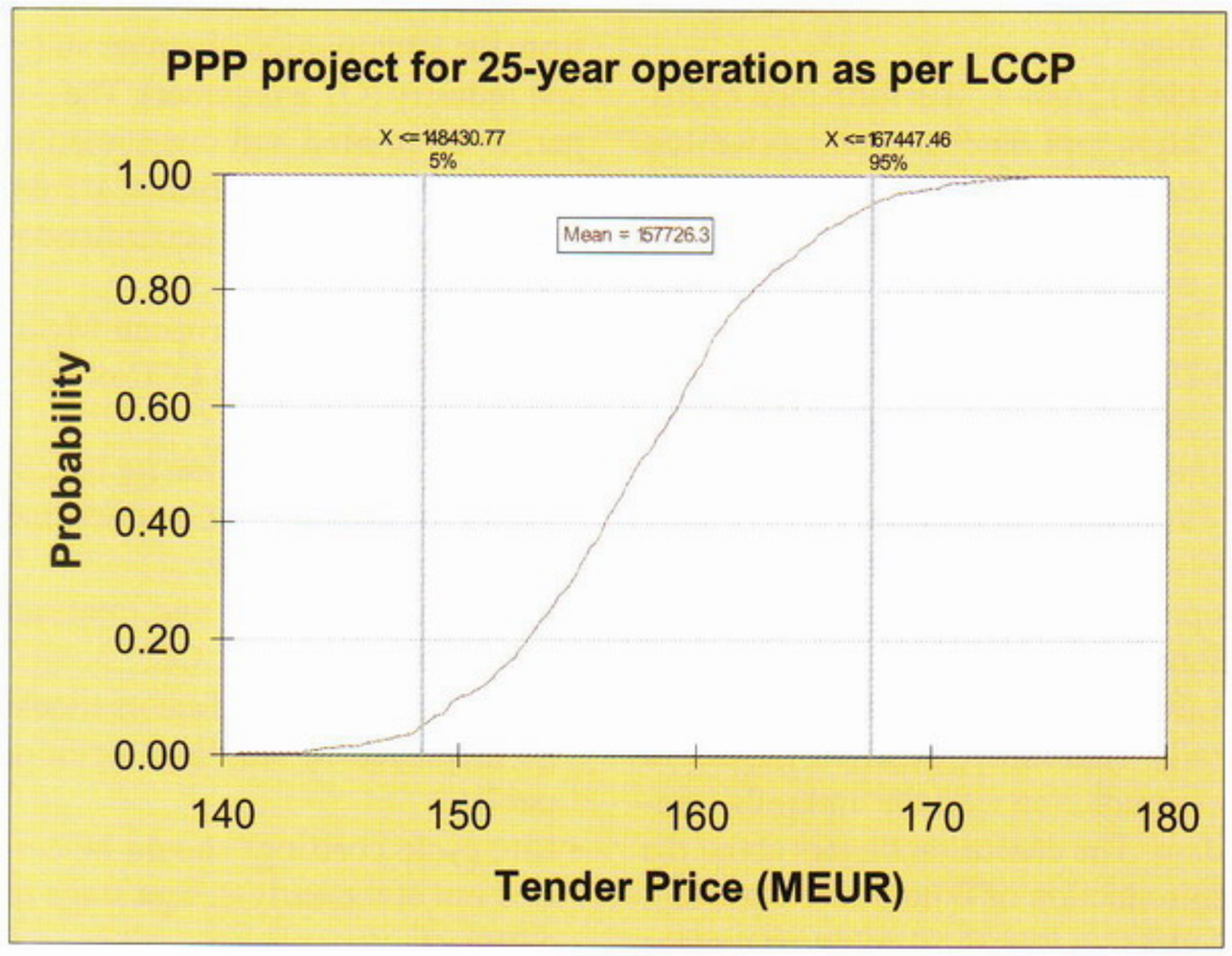

Figure 2. Tendering for a public private partnership – PPP project.

Current development: EuroLifeForm for probabilistics

For LCC to become widely accepted, concerns about uncertainties in forecasting must be overcome: costs; performance of a building, its components and assemblies. An important European RTD project EuroLifeForm is to develop a design methodology and supporting data, using a probabilistic approach, with a budget of 3.8 MEUR over 2001…04. Villa Real (FI) is the originator and a major partner and Taylor Woodrow (GB) the coordinator.

The newest theories and software are used for probability, risk, sensitivity analyses and optimisation (@Risk 4.5 Industrial using Monte Carlo simulation) and for complex multi-objective/multi-criteria decisions (Logical Decisions 5.1). In all seven partner countries data and information is collected; generic and on 9 case studies

The final outcome will be a model for LCC with Probabilistics – LCCP, in a software format, to replace deterministic (read: historic singular) values for costs and performance (read: service life) with a probabilistic approach, good for investors/developers/owners, designers, contractors, facil-

ities managers, users and other stakeholders. Plus a stint of environmental LCA incorporated.

As an example, a contractor can use LCCP software in his tendering for a BOOT or other type PPP or private project. As shown in the chart below, he is able to make a well informed decision on the final tender price based on probability, or risk he is ready to take. Also, this example clearly shows that there is quite a big risk involved; the future we don't know.

Unfortunately, in Finland we don't have readily available any public data base for costs nor performance covering their probabilistic values (eg triangular probability distribution model with min/max/most likely values). Contractors, however, have this expert information for their own use. Also, it is enough that the most important items, perhaps 20% of all, are duly considered.

Further information about EuroLifeForm is available at http://www.villareal.fi/elf/description.html.

A good presentation in easy-to-read PowerPoint format of all the aforesaid and much more is included in the proceedings of a related symposium held 04 Sep 2003 in Helsinki [3]. This book is available in the online bookshop at http://www.villareal.fi.

References

[1] Roger-France. J-F et al, Life Cycle Costs in Construction, EC DG Enterprise, 2003.

[2] Tupamäki, O, Construction Can!, Villa Real Ltd/SA, ISBN 951-97676-1-4, 1998.

[3] Tupamäki O, et al, Total LCC – Good for the Construction and Real Estate Cluster – CREC? – PROCEEDINGS, Villa Real Ltd/SA, ISBN 951-97676-7-3, 2003.

[1] ISO = International Organization for Standardization

[2] ENCORD = European Network of Construction Companies for Research and Development