Whole Life Costing (WLC): a common design methodology for building projects in Europe?

JEAN-FRANCOIS ROGER-FRANCE

Architect, MA (AA School London), Lecturer at the St Luc School of Architecture Brussels,
Architect Council of Europe (ACE- CAE) Convenor for the EEC in the Taskforce 4 WLC in Construction
75 rue Bodrissart, B-1410 Waterloo, Belgium, Tel. & Fax +32.2.353.25.33,
Email : jfrf@hotmail.com, jrf@artbuild.be

Abstract

The aim of this article is to investigate the use of WLC as a method to aid environmentally responsible investment decisions in construction projects. The use of two important discounting methods in Europe, the life-cycle approach and practical implications to conduct an environmentally relevant WLC are discussed. The proposed method is based on literature studies of managerial environmental accounting tools and on the work of the Task group 4 "WLC in Construction" created by the Commission of the European Communities in order to obtain convergence and harmonisation in WLC methodologies.

Conference topic: design strategies

Keywords: Decision-making and strategies of actions, whole life costing, building life cycle analys

DESIGN APPROACH

The term « Green building » expresses the desire to construct and use buildings in an environmental-friendly way. It is expected that the term does not remain just a slogan, environmental impacts associated with construction need to be described, quantified and analysed. As many LCA (Life Cycle Assessment) methods were developed in the past years, it has become possible to assess environmental impact caused by products or products systems. In this way, building elements or entire buildings can be investigated and possibilities for an ecological optimisation can be identified.

However, in order to make an optimal use of the LCA tool, all those concerned with construction must be familiar with its applications, potentials and limitations. An architect's approach to LCA might differ from that of a building contractor or of a building material manufacturer. LCA methodologies vary from country to country, with their own specifications and environmental regulations. ISO Standards define the general aspect of the LCA but not the detailed application.

European Commission Recommendations

In the Communication from the European Commission "The Competitiveness of the Construction Industry" dated 04.11.1997, 65 recommendations have been established. From these, a Sustainable Construction Group has been created with Mr John Goodall (FIEC) as Convenor and 3 Taskgroups (TG) were made. These objectives are explained in the "Competitiveness of the Construction Industry , An agenda for the Sustainable Construction in Europe" 20 May 01. [1] The three completed Task Groups (TG) are:

TG 1 on Environmentally Friendly Construction Materials, TG2 Energy Efficiency on Buildings, TG3 on Construction and Demolition Waste Management. Conclusions of these TG are available at the European web site
http://europa.eu.int/comm/entreprise/construction/index.htm

The European Commission recommendations underlines the need to establish guidelines. That would lead to LCA and Life Cycle Cost (LCC) normal standard procedures aiming for convergence in methods and metric at the European level. Assessment of environmental impacts over the lifetime of built facilities as well as estimates of LCC should be available to clients before construction work begins. Consideration should be given to make such assessments mandatory for public works valued above a given threshold. It is, however, crucial to ensure a general uniform knowledge of how the method should be applied at a European Level.

A Fourth Task Group TG4 has been created in September 2001 on behalf Mr J. A. CAMPOS (DG Enterprise of the European Commission) and with an Architect's Council of Europe (ACE) Convenor. This TG4 is constituted of 40 participants members of European organisations (Industrial, Construction and Research sectors), DG Enterprise, DG Environment and DG Internal Market. The terms of references of TG 4 are: "Draw up recommendations and guidelines on Whole Life Costing (WLC) of construction aimed at improving the sustainability of the built environment".

FROM LCA TO WLC

Definitions

Life Cycle Assessment LCA is a method to measure and evaluate the environmental burdens 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.

Life Cycle cost (LCC) and Through Life cost (TLC) are terms used to described the same process as Whole Life Costing (WLC). The terminology of WLC is more commonly used[2], and therefore in the present paper. Most of us use the process of WLC consciously or sub-consciously in our normal purchasing. When we buy a car, for example, we want to know not just the price, but the vehicle's running costs, such as estimated regular maintenance cost, cost and timing of replacement of time-expired parts as well as residual value on disposal. The same is true for buildings. We are driven by cost of ownership issues. We are frequently willing to pay a higher capital cost if we have some guarantee that this will be more than offset by lower maintenance costs.

The definition from the developing ISO Standard 15686 [3] on WLC is "a tool to assist in assessing the cost performance of construction works, aimed at facilitating choices where there are alternative means of achieving the client's objectives, and where those alternatives differ not only in their initial costs but also in their subsequent operational costs".

Differences and similarities

WLC and LCA in construction industry have been developed separately in response to economic and environmental issues but the two tools have much in common[4].

The key similarity is that both utilise data on:

- Quantities and specification of materials used
- (mass, thickness, density…)
- The service life the materials could or will be used for.
- The maintenance and operational implications of using the products
- (assumptions about building use)
- End of life proportions to recycling (and sale value) and disposal. Service life for the same material can vary in different building context.

The differences are:

- Conventional WLC methods do not consider the process of making a product; they are concerned with the market cost. LCA considers production.
- WLC is usually discounted to present value over time, whereas environmental impacts are not discounted.

UK Methodology for WLC

The UK Government procurement policy is concerned by the optimum combination of whole life costing and quality to meet the needs of the customer, which means the same as "most economically advantageous tender". This enables clients to specify what they need to meet their own operational and policy objectives.

The WLC methodology described by the UK Construction Clients Forum and the BRE [5], is an iterative process. At each decision stage, calculation of the whole life costs will be refined to provide increasing certainty of the total whole life cost of the project.

The breakdown of the costs involved at each stage is:

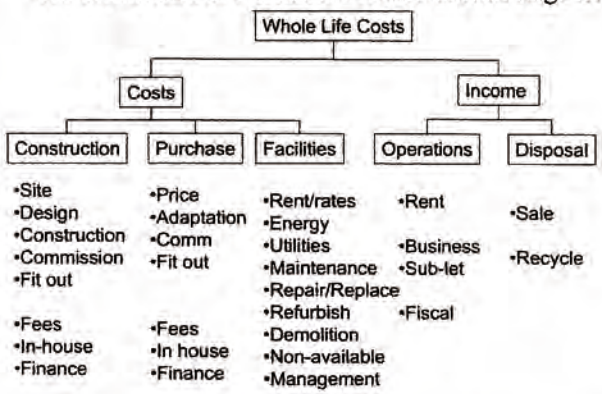

Figure 1 : Breakdown of Whole life costs of ownership of a constructed asset. (based on HM Treasury Procurement Guidance N°35 LCC)

In order to obtain maximum benefit from the use of whole life costing, its computation should be undertaken at each stage of procurement of the project. In the early conceptual stages it will only provide a broad estimate of the costs, but when decisions are made and the design details defined, it will provide a prediction of the total cost of owning and operating the asset. At the initial budget stage, the BRE methodology for assessing capital costs is based on the use of historic costs per square meter. This subsequently firmed up to based on actual UK labour and material costs.

WLC additionally takes account of post occupation costs. The aim is to arrive at a WLC plan applicable to all stages in acquisition and the use of constructed asset, as the basis for the client's procurement decision. The original assumptions are replaced by better assessments of quantities, price and predicted performance of alternative components, materials and services. When considering WLC, the designers should work in close collaboration with the supply chain, the main contractor, suppliers and manufacturers. The designers need to decide which elements of the construction should be long life when supported by periodic maintenance and which should be short life and replaceable [6].

In this way WLC and quality are combined to obtain the best value for money. It should be feasible to set minimum standards and award quality points to those bidders who exceed those standards, provided tenderisers, are notified in advance. But how it is possible to value such above standard quality bids in relation to lower priced bids that meet the minimum ? Where is the line between acceptable measures and arbitrary judgements?

For example, could the buyer weight the quality of evidence submitted to support product claims ? A particular example might be to score independent third party certification higher than other forms of documentary evidence even though all evidence confirms that minimum standards are met.

Without financial incentives and legislation, there needs to be an investment in education and demonstration projects to prove the benefits of the whole life approach However, commercial clients are already showing an interest because they can see benefits in managing the risk of life cycle costs to maintain the underlying asset value and to give tenants a security on fixed service charges without surprises.

A BRE/Department of Environment, Transport and the Regions survey in 1999 showed that despite the recognised benefits WLC is currently used by only 25% of construction clients in the UK [7]. The client has a key role. Industry expects Government to lead by example as clients for major public works, as regulators and legislators.

THE EVR MODEL

Prof. Vogtländer elaborated with TU Delft an eco-value methodology where the LCA environmental aspects werelinked with WLC aspects. The basic idea of the EVR (Eco-costs/Value Ratio) model is to link the 'value chain' (Porter, 1985) to the ecological 'product chain'.

In the value chain, the added value (in terms of money) and the added costs are determined for each step of the product "from cradle to grave".

Similarly, the ecological impact of each step in the product chain is expressed in terms of money, the so called eco-costs [8]. See Figure 2.

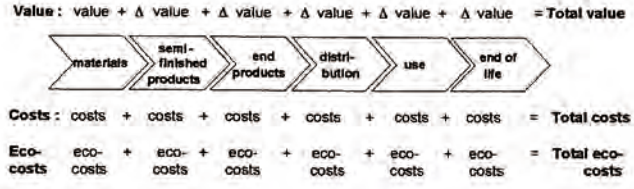

Fig. 2: The basic idea of combining the economic and ecological chain: "the EVR chain".

The eco-costs are 'virtual' costs: these costs are related to measures which have to be taken to make (and recycle) a product "*in line with earth's estimated carrying capacity*". These costs have been estimated on the basis of technical measures to *prevent* pollution and resource depletion to a level which is sufficient to make our society sustainable.

Since our society is yet far from sustainable, the eco-costs are 'virtual': they have been estimated on a 'what if' basis. They are not yet fully integrated in the current costs of the product chain (the current WLC). The ratio of eco-cost and value, the so called Eco-costs / Value Ratio, EVR, is defined in each step in the chain as:

$$EVR = \text{eco-costs} / \text{value}$$

For one step in the production+distribution chain, the eco-costs, the costs and the value are depicted in Figure 3.

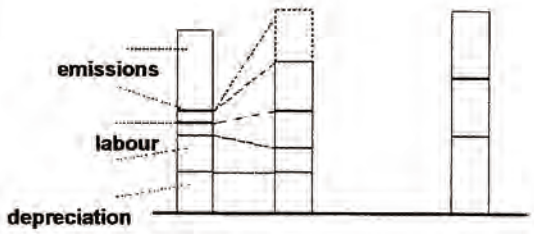

Fig. 3: The decomposition of "virtual eco-costs", costs and value of a product

The five components of the eco-costs have been defined as 3 'direct' components plus 2 'indirect' components [8]:

- virtual pollution prevention costs, being the costs required to reduce the *emissions* of the production processes to a sustainable level (Vogtländer et al., 2000)
- eco-costs of *energy*, being the price for renewable energy sources
- *materials* depletion costs, being (costs of raw materials)x(1-_), where _ is the recycled fraction
- eco-costs of *depreciation*, being the eco-costs related to the use of equipment, buildings, etc.
- eco-costs of *labour*, being the eco-costs related to labour, such as commuting and the use of the office (building, heating, lighting, electricity for computers, paper, office products, etc.).

Based on a detailed cost-structure of the product, the eco-costs can be calculated by multiplying each cost element with its specific Eco-costs / Value Ratio, the EVR. These specific EVRs have been calculated on the bases of LCAs. Tables are provided for materials, energy and industrial activities.

In the EVR model Eco-efficiency is defined as:

$$\text{eco-efficiency} = (\text{value} - \text{eco-costs}) / (\text{value}),$$

or $\text{eco-efficiency} = 1 - EVR$

In this methodology, WLC ("costs") are separated from LCA ("eco-cost"). The TG4 decided in the meeting on the 15 February 02 to only focus on WLC.

DIFFICULTIES

It has to be underlined that in existing WLC methodologies that integrate evaluation of managerial environmental tools (such as the hurdle rate principle [9]), several problems occur in the estimation of environmental and micro-economic dimensions. The difficulty of estimating the WLC of a building and its components as well as the problems with discounting methods, implies that reliability of results from WLC can be discussed. Continuously shifting environmental regulations and rules further contribute to this problem. The similarity between the concepts of different managerial accounting tools and

the multifaceted grouping of environmental costs means that several concepts are difficult to apply in practice [10].

It therefore essential to develop and use methodologies and tools that complement each other rather to develop combined LCA-WLC methodologies. WLC methodologies are complementary to LCA methodologies.

THE EMAT METHOD

A proposed methodology that permits contract award to the Economically Most Advantageous Tender (EMAT) has been set up by Mr Harrower (Convenor of the EMAT Taskgroup) in the framework of the working Group on Abnormally Low Tenders (ALT) created by the Council, the European Parliament, the Economic and Social Committee of the Regions on the Competitiveness of the Construction Industry [11].

The primary objective of this EMAT method is to prevent, detect and eliminate abnormally low tenders in the European Construction Industry. It provides a transparent and public auditable mechanism and procedure for the evaluation of tenders to determine the economically most advantageous tender on the basis of best quality and value for the client rather than only lowest price.

Essential elements to be determined to establish the award criteria for the construction project are:

- Quality and Life Cost criteria (WLC)
- The relationship (ratios) between quality, life cycle costs (WLC) and initial construction cost (the tender price)
- Weightings for quality and life cycle cost criteria
- Thresholds and mandatory criteria.

The report notes that WLC have to be the subject of a separate working group, not yet established.

With a non exhaustive checklist tables of quality criteria in different stages of the design (detailed design, preliminary design, design and build) it appears possible that the contracting authority selects, amends or supplements the contract in order to suit the requirements of individual projects. The significance of quality criteria on the outcome of the scoring procedure is dependant on the quality/price ratio, the number of criteria and weightings.

Where the WLC of a particular element of the construction under assessment are financially significant, those elements should be separately assessed. This is particularly important when considering the energy of consuming elements such as electrical, heating, air conditioning and similar systems.

The following factors [11] should be assessed and incorporated into the award mechanism:

- Total project life
- Life of the element
- Operating Costs
- Maintenance Costs
- Replacement Costs
- Disposal Costs

Each European member state will have a number of domestic versions that will differ from other member states. ISO/TC59/SC14 is currently preparing a committee draft of ISO 15686-1 Buildings and constructed assets – Service life Planning – Part 5: Life Cycle Costing headed by the BRE.

It has been suggested by the BRE that TG4 should:

- liase with EMAT Task Group to ensure brief in support of the principles of EMAT ideals.
- develop a fully transparent methodology for carrying out WLC based on the next ISO standard.
- develop scoring criteria for WLC
- make recommendations on how WLC should be handled under build to detailed design types of procurement.

This methodology is still in a preliminary stage. However, It is considered with great interest by the United Nation (Trade and Development) and the World Trade Organisation in a technical guide devoted to trade in Developing Countries [12].

CONCLUSION

TG4 preliminary conclusions for February 2002 are that WLC methodology have to complementary to LCA methodologies in the design process. A standardised approach appears essential. As with the European Procurement Directives, it must be based on principles of transparency, equal treatment and competitive procurement. The approach has to be close to the new ISO 15686 which is currently in realisation by the BRE. The work of TG4 should carry out in support of the principles of EMAT.

REFERENCES

1. COMPETITIVENESS OF THE CONSTRUCTION INDUSTRY "*An Agenda for sustainable construction in Europe*" A report drawn up by the Working Group for Sustainable Construction with participants from the European Commission, Member States and Industry, 20 May 2001.
http://europa.eu.int/comm/entreprise/construction/index.htm
2. EDWARDS S., BARTLETT E. DICKIE I., *"Whole life costing and life cycle assessment for sustainable building design"* BRE Digest 452, November 2000.
3. International Standards Organisation, ISO 15686-1 Buildings and constructed assets- service life planning Part 1: General principles. 10.3. 1999.
4. EDWARDS S., BARTLETT E. DICKIE I., *"Whole life costing and life cycle assessment for sustainable building design"* BRE Digest 452, November 2000.
5. Construction Client's Forum, "*Whole Life Costing, A client's guide*" London, 1999.
6. Office of Government Commerce, "*Construction Procurement Guidance*" N°7 Whole Life Cost, 2001 (?).
7. BRE/DTRE Survey 1999.
8. Dr VOGTLANDER J. « *Summary, The Eco-costs / Value Ratio, ERV*", Aiming better, Technical University of Delft, may 2001.
9. GRAY R. H., BEBBINGTON J., WALTERS D., *"Accounting for the Environment"* Paul Chapman Publishing Ltd London, 1993.
10. GLUCH P. *"Life Cycle Costing, a managerial environmental accounting tool for building project?"* Proceedings of the International Conference Sustainable building 2000, 22-25 October 2000, Maastricht, AENAS Technical Publishers, pp. 673-675.
11. Report and Recommendations of the EMAT Task Group *"A proposed methodology that permits contract award to the Economically Most Advantageous Tender*" July 2001.
12. Letter from Mr Denis BELISLE, Centre du Commerce International, Conférence des Nations Unies sur le Commerce et le Développement to the EC (DG Enterprise), 21 December 2001.