Life-Cycle Cost Methods And Tools

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Summary: Life cycle economics is the only way to control individual buildings and real estates over long terms. VTT, in co-operation with two consulting firms has developed a systematic way to apply life-cycle economics on different stages of building design. This model has been presented in this paper. It is based on investment costs modified to annual costs, yearly maintenance costs, renovation costs modified to annual costs as well as on an analysis of benefits like incomes, effects on quality, and other nonqualified factors.

Keywords: life cycle economics, building design

1 ACKNOWLEDGEMENTS

This Life-Cycle Cost Estimation Methods (LCC) project has been carried out in co-operation with two Finnish consulting companies Granlund Olof Oy and Rapal Oy and VTT Building Technology research organisation. The first phase project was partly financed by the Technology Development Centre of Finland (TEKES) and ended in Dec.1997 and the second phase is still going on.

2 NEED FOR LCC METHODS AND TOOLS

The interviews with Finnish facility management staff and building designers have proven that there is lack of systematic methods and tools for design of buildings' life-cycle cost. However occupancy cost are usually the second largest cost in the business after labour cost. So better design of life-cycle cost seems to offer quite large saving potentials. The objective of this project is to develop life-cycle cost design methods and tools which are applicable both for building maintenance and design of new or renovation objects.

The phases of the life cycle are suggested to be as follows: acquisition, use and maintenance, renewal and adaptation and disposal.

The service life of buildings may also be divided in three life-times

- functional life-time (for example 20…25 years in case of residential buildings)
- technical life-time (for example 75…100 years)
- economic life-time (for example about 50 years)

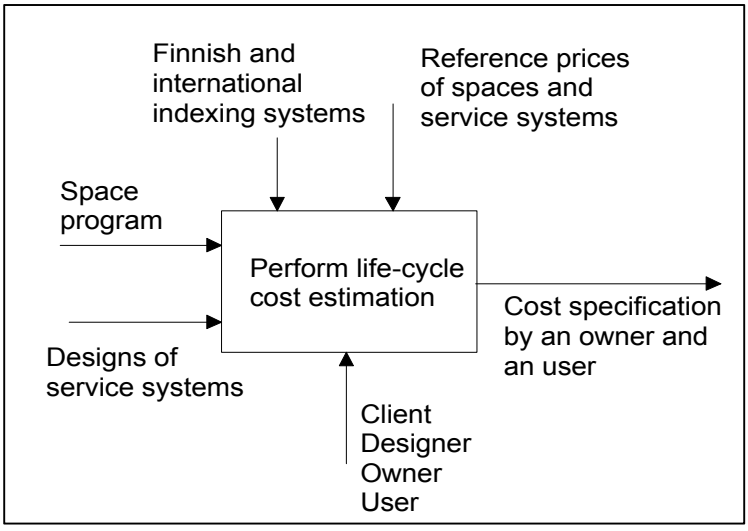

Figure 1. Simplified activity model (IDEF-0) of the life-cycle cost estimation method.

Reference information about LCC models, abstarcts and files should be feeded to www, for which purpose are going on efforts in VTT (BENCHNET). The service life of products is dependent on it characters to be able to stay permanent as well as quality of production process.

On the whole, life-cycle management is an iterative process aiming at the selection of the most suitable and economic solution from many alternatives. Also consideration of buildings' environmental impacts should be part of the LCC design process.

Life-cycle costing can be applied from the very early need analysis design stages to the detailed design of building components. Life-cycle costing can roughly be divided in the following three design stages.

- analysis of functions, setting quality targets and level of energy consumption on the building level
- defining the building, its architecture, quality and functional targets on the system level
- building design on the component level

The estimation of profit on different levels is based on defining the annual demand of profit which covers yearly costs. Then the prototype uses as directive reference values when generating investing costs following rates of interest

- 10% in the period of ten years (directive meaning)
- 7% in the period of 25 years (suitable for example energy economic analysises)
- 4% in the total usage age of building (informatic meaning)

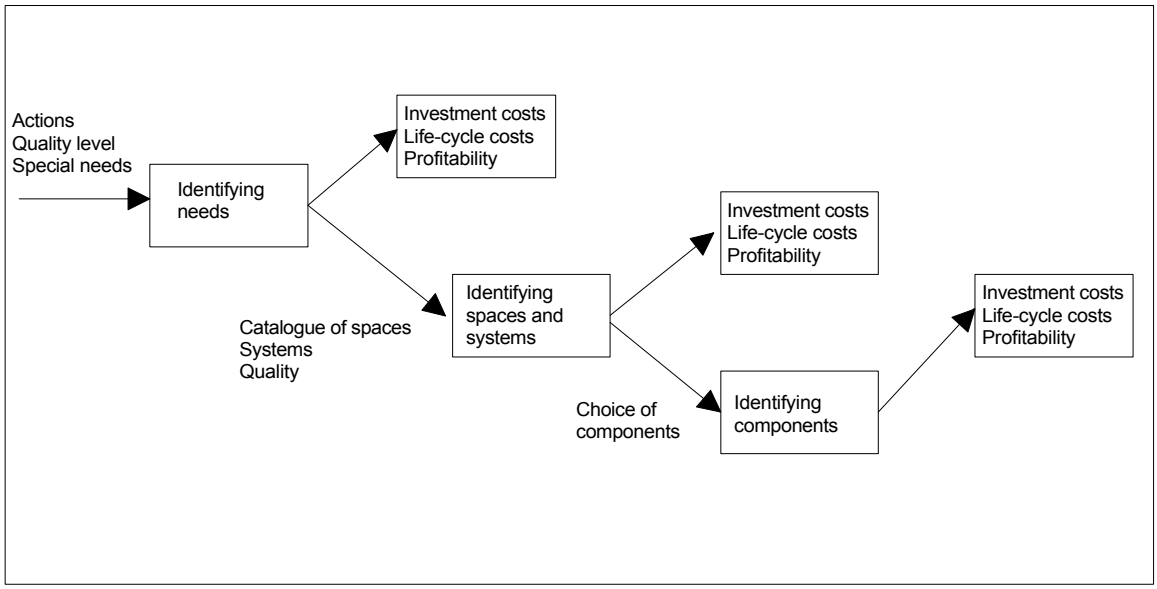

Figure 2. Iterative life-cycle costing on different stages of building design.

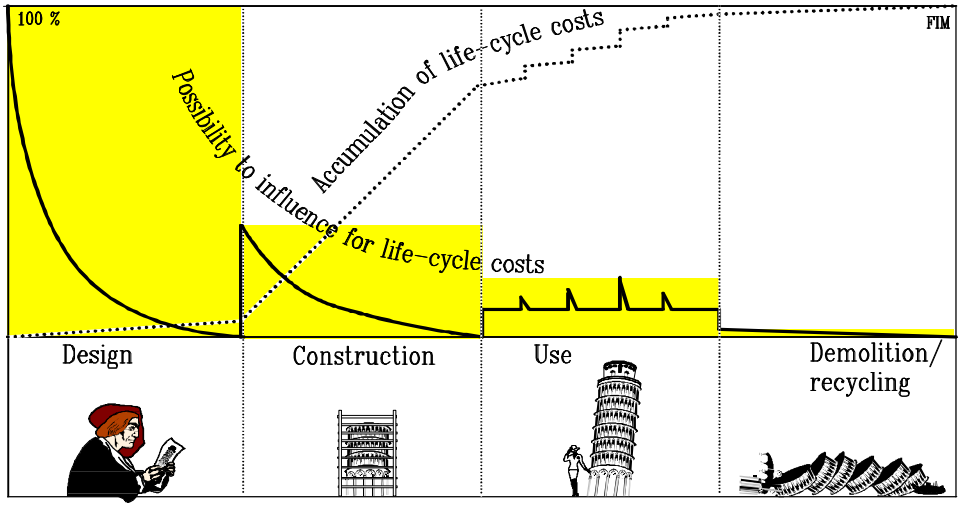

Figure 3. Most part of life-cycle cost are fixed in early design stages.

In this work the existing Finnish Space-Based Cost Estimation method is complemented especially with the maintenance cost factors of technical systems (HVAC and electrical) and the costs of these are divided for spaces. Occupancy costs will be reported from the viewpoints of a building owner and user. Also recommendation for a new indexing system for control of occupancy cost are under development.

3 LIFE-CYCLE COSTING MODELS AND TOOLS FOR BUILDING SERVICE SYSTEMS

During years 1993-1994 Granlund Oy developed models and prototype tools (HVAC) for the management of life-cycle cost of building service systems. By developing these models and tools further,it is possible to produce real software tools for different design stages and also devices to support decision-making in building maintenance. The central improvement areas are further development of price-list and consumption databases, integration of energy calculation software, definition of methods describing how to divide cost of service systems for spaces and development of a tool for electricity works management. The final objective is a software package including all the previous mentioned properties for comprehensive management of a building's life-cycle cost.

A standardised classification of maintenance cost has been published in Finland (Appendix 1, Figure 1). The main purpose of this classification is to make it easier to assign different facility management cost in a systematic way, draw up budgets, control maintenance costs, conduct accountings and understand the meaning of maintenance cost in connection with building planning. In this project we have interviewed Finnish real estate managers to clarify if they use this standard classification and what kind of further development needs they see in it. This project will recommend of new classification system for occupancy cost control. Life-cycle costs are reported according to this new classification and separated as cost of a building owner and a client.

4 LIFE-CYCLE MODEL OF FACILITY MANAGEMENT

Life-cycle cost consist of investment and maintenance (care and renovation) costs. In Tila-Suku facility management software developed by Rapal Oy investment and maintenance cost are defined per space unit.

Investment costs are allocated by space based on the Target Cost Method of the Finnish Building Cost Information System. Investment costs are transformed to annual cost with the annuity method. Then investment cost are comparable with the maintenance cost.

Maintenance costs are calculated with the help of the actual real estate maintenance cost information book published by the Building Economy Laboratory of Technical University of Helsinki. Consumption of heat and electricity, unit rates of cleaning works and renovations are allocated per space unit. Cost items which are not based on unit rates are allocated as space and client based (e.g. building managing, services, water, special equipment service, insurances, waste service) are divided for spaces by their areas.

The resulting target prices and maintenance costs are calculated. Generally information of actual cost are obtained in the form of total cost by cost items. In Tila-Suku the actual cost can be allocated for the spaces by calculated cost. Then for example rent or profit of each space can be estimated by investment and maintenance cost of this space.

In case of comparing concurring alternatives with each it may be reasonable to apply a manysided cost-effectiviness model (cost analysis, efefctivity analysis and alltogether) in which LCC calculations do usually have a leading role:

4.1 Cost analysis

- Input factors collection
- Cost calculations (product costs and building costs)
- Life-cycle costing
- Energy economical calculations

4.2 Effectivity analysis

- Price and value analysis, price flexibility, concurrence
- Use of time, Time of use
- buildability, integration with other technology, modifibility, terms of maintenance
- comfortability, Safety, Design (architecture etc.)
- Effects on environment
- marketing analysis
- effects on employment and skill

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4.3 Alltogether

Scoring, alternative comparisons, Technological portfolio – optio, cash flow analysis, profit analysis, value analysis, sensitivity analysis.

5 RECOMMENDATIONS

The LCC-model and tool presented in this paper can be applied in various supporting tasks. The model can be used to develop computer-based tools for specific knowledge areas. Some kinds of tools are in use in different countries but much research work is still needed.

The recommendations are as follows

- we should develop a standard for LCC-model to be utilized in co-operation with different countries world-wide
- the model should cover spaces and technical systems
- the analysis should also include the analysis of the most important environmental effects on chosen technical systems
- the model must be independent of the information technology used in different countries and companies

6 APPENDIX 1.

The Finnish official classification of facility management cost

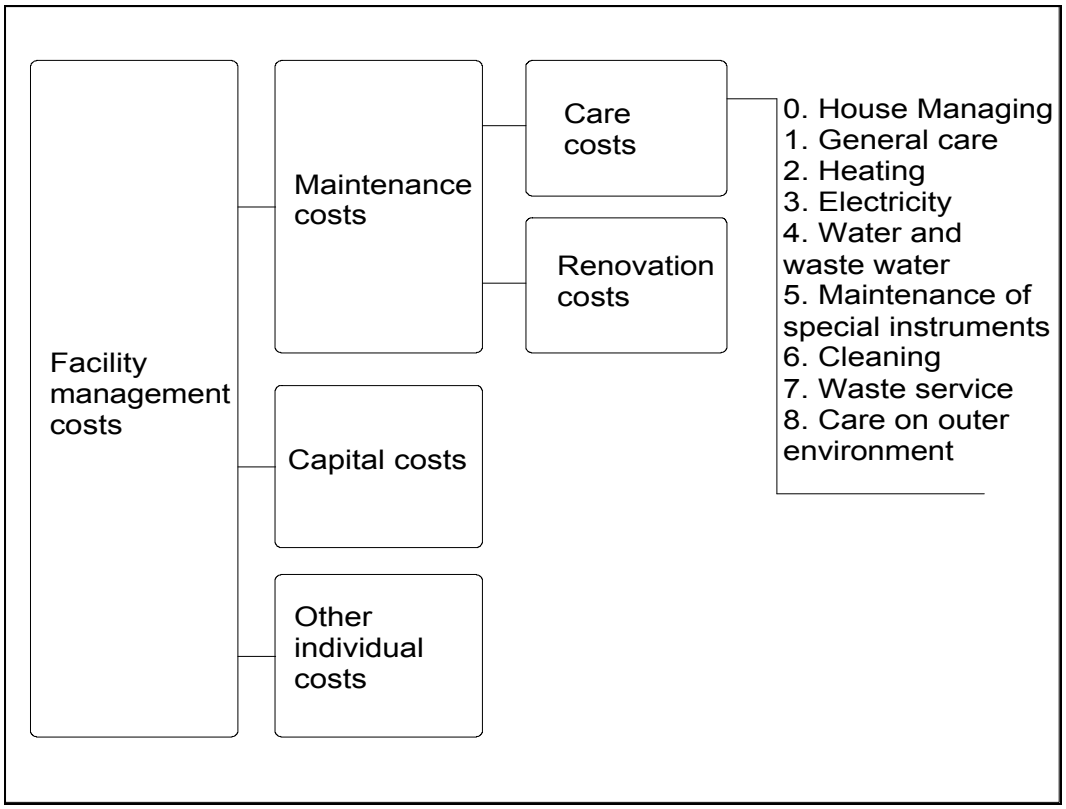

Figure 1. The official classification of Finnish facility management cost.

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