LIFE CYCLE COST ANALYSIS IN PUBLIC PROCUREMENT

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Summary

The paper proposes to provide information on potentialities and procedures of Life Cycle Cost Analysis (LCCA) of buildings during the stages of investment planning and design. The paper is mainly focused on the use of life cycle cost analysis in public procurement. Proposed methodology for sustainable construction procurement by public sector clients consists of setting the objective and scope of LCCA, defining the key parameters, setting options for analysis, gathering data to evaluated options, performing the economic evaluation of options, incl. risk and sensitivity analyses, and Final Report. The application of methodology is verified on the example of public buildings, which is the Central Depository of Museum of Decorative Arts in Prague. Case study consists of preliminary LCCA for strategic investment decisions and detailed LCCA for options of key equipment (as a part of structural design). The final section summarizes the client's benefits of LCC calculation integration into decision-making processes within building preparation.

Keywords: life cycle cost, investment, public procurement, decision

1 Life cycle costing

1.1 Principle of life cycle costing

Life cycle costing is one of methodologies that can be used to provide a more comprehensive view of costs. Life Cycle Costing (LCC) has commonly been considered as the means by which initial, maintenance, replacement, operating and refurbishment costs are combined into a single economic figure to be used as the basis for informed decisions making. LCC provides a basis for contrasting initial investments (design, professional fees, construction costs) with future costs over a specified period of time (usually building life). The future costs are discounted back in time to make economic comparisons between different alternatives strategies possible. LCC techniques are usually used to compare the cost of alternative building components or systems over their economic or technical life. The purpose is to help to make more informed decisions. A component or a system with the lowest lifecycle cost is recommended as more appropriate than the one with the least initial cost.

1.2 History of life cycle costing

Life cycle costing has been described in literature in different forms for many years. In 1971, RICS established *Building Maintenance Cost Information Service*. In 1977, the British Ministry of Industry published material "*Life-cycle costing in the management of*

assets." In 1983, it was published a framework for data collection, which may be used to quantify life cycle costs of the project. Since 1992, the concept of life cycle costs has been accepted as a standard in the UK (*BS 3843 (1992*)). The definition of life cycle cost was revised in 2000 and incorporated in standard *ISO 15686 Part 1 Service Life Planning*. In 1999, *Whole-Life Cost Forum* was founded and *WLC Comparator Tool* was created. In 2001, a task group, TG4, was formed under the framework of the Working group for sustainable construction for drafting a report on life cycle costing in construction and to make recommendations on how to integrate LCC into the European policy making. The last major initiative is *"A common European methodology for Life Cycle Costing"* (2007).

2 Potentialities and procedures

The primary application of life cycle cost analysis (LCCA) can be seen in its use as a tool for effective selection between project alternatives, at any stage of the life cycle of the project. Most beneficial is the use of LCCA especially in the design phase of construction. The opportunity to influence the life cycle cost decreases with the development of the construction project.

2.1 Methodology

The preliminary LCCA processed in pre-investment phase is followed by the detailed LCCA in the investment stage (design). Simultaneously, the detailed analysis for the key component is processed. The work procedure of the LCCA is defined for three levels:

- Preliminary LCCA for strategic investment decisions,
- Detailed LCCA for design options,
- Detailed LCCA for options of key structures, systems and equipment (as a part of structural design).

The application of LCCA in each level consists of the following steps:

- Setting the objective of LCC analysis,
- Setting the scope of the LCC analysis,
- Defining the key parameters,
- Setting options for analysis,
- Gathering data to evaluated options,
- Performing the economic evaluation of options, incl. risk and sensitivity analyses (if required),
- Final Report.

2.2 Public procurement

LCCA provides a powerful economic view of the building in its design phase. LCCA methodology is crucial for the public procurement of construction works because allows to include the total cost of the acquisition, use and disposal of construction in decision making. The methodology can be used in two key phases:

- Defining the technical conditions (optimal level of LCC)
- Bids evaluation (LCC as a criterion of value).

Assessing the design of buildings (investment projects) in terms of life cycle cost is one of the ways to ensure meeting the criteria 3E, ie. their economy, efficiency and effectiveness.

This is particularly important for projects financed from public funds, which should clearly demonstrate financial viability.

3 Case study

The case study briefly summarize the results of the LCCA applications at the preparation of public buildings, in this case the Central Depository of Museum of Decorative Arts in Prague. New building of the Central Depository is designed to solve unsatisfactory state of the existing depositories and their fullness. Technical parameters of design are: built-up area 2827 m^2, floor area 10331 m^2, building volume 59384 m^3. This building is going to be financed from public funds.

3.1 Preliminary LCCA

The purpose of preliminary LCCA was to obtain data for investment decision. Preliminary LCCA was carried alternatively for period 30 and 50 years. Construction costs and operating costs were qualified estimated on the basis of design documentation and fees were tendered (public contract). Software *Buildpass* was used to estimate the replacement costs. (Buildpass is focused on qualified planning of the renovation and maintenance of constructions. The tool is based on reference databases of constructions and structural elements, which will enable the gaining of fast results or detailed models. www.buildpass.eu). Besides the total life cycle costs and their net present value (NPV), the costs per 1 m^2 of usable area were quantified. Disposal costs are not subject to analysis. Furthermore, the sensitivity analysis was performed to examine how LCC is influenced by changes in some of the key economic variables (in this case: discount rate, period of analysis).

Tab. 1 *Life cycle costing at whole building level – new building of Central depository*

Project: Central depository **Period of analysis: 30 years**		**Discount rate: 3%** **Price level: 2012**		
Item	**Category costs**	**Unit costs (CZK/m^2)**	**NPV**	
			Category cost	**Unit costs (CZK/m^2)**
Construction costs	*350 000 000*	*33 879*	*350 000 000*	*33 879*
Design, engineering fees	*13 600 000*	*1 316*	*13 600 000*	*1 316*
Land	*30 000 000*	*2 904*	*30 000 000*	*2 904*
Initial costs total	393 600 000	38 099	393 600 000	38 099
Replacement and maintenance costs	156 386 500	15 138	101 559 631	9 831
Operation costs	127 752 000	12 366	83 466 519	8 079
End of life costs – excluded	0	0	0	0
LCC over 30 years period	677 738 500	65 602	578 626 150	56 009

The decision to build the Central Depository as a low-energy building is correct in terms of LCC. Operating costs per 1m^2 floor area are significantly lower; they represent only 25 % of operating costs in currently used depositories.

3.2 Detailed LCCA

Detailed LCCA was processed for component shading and glazing. This component significantly affects the energy consumption for heating and cooling. Design assumes 199 windows of the same size and parameters. There were designed and evaluated 6 variants which varied with thermal resistance factor of glazing and with range of shading (sunblind). Each of the proposed variants was better than the original version and resulted in LCC savings. Minimal increase in construction cost of CZK 2 million (0.57 % of total costs), will save energy costs CZK 10 million (NPV = CZK 6.75 million) in the analysed period of 30 years, the savings in LCC are calculated CZK 8 million (NPV = CZK 4.5 million). The payback period (considering only the cost of energy) is only six years. Furthermore, the sensitivity analysis was performed to examine how LCC is influenced by changes in the price of energy.

4 Conclusions

Life cycle cost analysis brings a whole new economic view of the building in its design stage. The assessment of building investment in terms of life cycle costs is one of the ways to ensure economy, efficiency and effectiveness. The client's benefits of LCCA integration into decision-making processes within building preparation are:

- Transparency and sustainability of future construction costs,
- Complex planning of future costs associated with the ownership of buildings,
- Influencing future costs already in the design stage,
- Evaluation of design alternatives (buildings or components),
- Assessment of a compromise between the technical parameters of the project and the cost (substitution of materials, technologies, etc.)
- Greater emphasis on achieving a higher "value for money".

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