

## Identification and Breakdown of Operating Costs Throughout A building's Lifetime

Frantisek Kuda, Eva Wernerova, Marek Teichmann and Stanislav Endel

Department of Urban Engineering, Faculty of Civil Engineering, Technical University of Ostrava,  
1875/18 Ludvika Podeste, 708 33 Ostrava, Poruba, Czech Republic

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**Abstract:** The study deals with identification and breakdown of operating costs resulting from operation of buildings. It highlights the range of operating costs which derives primarily from the building type and location and describes the critical importance of the pre-investment phase which influences the operating costs significantly. In addition, the study identifies sources of data and information for identification of operating costs in the pre-investment, design and operating phases.

**Key words:** Life cycle costing, world life costing, methods of LCC, standards of LCC, operating, phases

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### INTRODUCTION

Building life-cycle cost analysis is an important tool for investment decision-making. Such analysis includes in its assessment not only the capital costs but also, the costs of operating, renewal and maintenance and disposal of the building. Capital costs pose the greatest financial burden on the investor during construction. However, other costs occur during the building's lifetime, associated with its use that exceed the capital costs in their sum. For investors constructing buildings for the purpose of selling, it is understandable that they try to minimise the capital costs and disregard the other costs occurring during the building operation, since, they are transferred to the future owner or user. However, these investors too should include the total building life-cycle costs in their decision-making in an effort towards sustainable development and energy consumption reduction. After all, current legislation prescribes the elaboration of a Building Energy Efficiency Certificate (BEEC), assessing the building in terms of its energy intensity, total energy supply to the building and breakdown into types of consumption (heating, cooling, hot water, etc.) and offering brief recommendations of measures leading to reducing the energy intensity. Both the certificate and the current legislation only deal with the issue of energy which indeed represents a substantial portion of the building operating costs but they are not concerned with the overall building costs. Cleaning costs, for example, may amount to hundreds of thousands a year in large office or residential buildings. A large proportion of the costs can be influenced by appropriate adjustments to the structures, materials or layout in the project preparation phase. Unfortunately, even public contracts fail to take into consideration the overall

building costs and decisions are based mostly on the lowest bidding price for building acquisition. In public tenders for buildings, building life-cycle cost analysis should be required from all bidders. To do that, however, requires a unified methodology for building life-cycle cost analysis and definition of cost categories.

### MATERIALS AND METHODS

**Operating cost identification methodology:** First and foremost, all the available information and data sources need to be prepared. Initial information necessary for identification of various operating costs is contained in well-developed project documentation and technical reports specifying structural, technical, material and process solutions (hereinafter, referred to as PD and TR, respectively). The more detailed the documentation, the better information is obtained for identifying the costs. Requirements for the level of documentation detail are increasingly less strict and implementation documentation is often replaced with documentation for building permits, particularly for single-family houses and thus does not include all the detailed information. The further steps are as follows:

- Identification of various operating costs
- Identification of sources of necessary information
- Calculation and identification of annual amounts of the various operating costs throughout the building's lifetime
- Inclusion of operating costs among the other life-cycle costs
- Calculation and comparison of life-cycle costs according to a chosen financial indicator, including the value of money in time (NPV, IRR, DPP, SIR, ...)

Identification of operating costs depends on the type of the capital investment plan (hotel, hospital, school, office building, apartment building, single-family house and others). Depending on the type of building, some operating costs may be entirely absent (greenery maintenance, guarding, etc.) or may be extended with additional specific items (clean bedding provision, periodic maintenance of specific equipment, rodent control). Another difference will be in the method of treating the investment (sale/lease). If the investment project is of a developer type with the intention to sell the property or sell its component parts one by one, the investor disregards the operating costs, since, they are transferred to the future owner, thus, saving both money and time by not analysing them. The operating costs will also differ depending on the project location and method of use of the building. The building location influences not only costs of energies and water but also waste collection, property tax, etc. Each building has its specific features which need to be taken into account. Provision of background information requires coordination among all the stakeholders (investor, architect, specialist technicians, project and facility manager) and cooperation of authorities and concerned public bodies.

**RESULTS AND DISCUSSION**

**Background information for identification of operating costs:** Operating costs can be identified depending on the LCC analysis needs in various phases of the building life-cycle. Table 1-3 describe the required information and its sources necessary for identification of operating costs (the breakdown of operating costs shown here is convenient for apartment and similar buildings).

The pre-investment phase concerns mainly strategic decisions whether to implement the plan or not renovate or build new or invest the funds in a different project (preliminary feasibility study, feasibility study). If the decision is made to build new, this is followed by comparison of various options that come into consideration then in turn a study, draft project design and zoning proceeding documentation are made. The background information for identification of the operating costs is very rough in this phase and it depends largely on expert estimates or previous experience with similar projects or information from comparable buildings operated by the investor. Up to 80% of the future costs can be influenced at the start of the project design phase. The information becomes more refined as the

Table 1: Sources of data and information for identification of operating costs in pre-investment phase

Operating Costs (OC)	Pre-investment phase	
	Required information	Information sources
<b>OC1</b>		
Energies	Investment plan description:	Expert estimates
Energy for heating	Location	Data from similar projects
Energy for hot water	Building type	Historical data from projects currently in use
Energy for cooling	Building size	
Energy for ventilation	Building uses and operations	
Energy for humidity adjustment	Building lifetime	
Energy for shared area lighting	Equipment used	
Other energy consumption in apartment units	Technical, structural and material solutions	
Other energy consumption in shared areas	Staffing	
<b>OC2</b>		
Drinking water and wastewater		
Water charges		
Sewerage charges		
<b>OC3</b>		
Waste disposal		
<b>OC4</b>		
Cleaning		
<b>OC5</b>		
Greenery maintenance		
<b>OC6</b>		
Building guarding and security		
<b>OC7</b>		
Building and property insurance		
Property insurance		
Other insurance		
<b>OC8</b>		
Administration and servicing charges		
Property tax		
Inspection and servicing charges		
Other charges		

Table 2: Sources of data and information for identification of operating costs in design phase

Design phase		
Operating Costs (OC)	Required information	Information sources
<b>OC1</b>		
Energies	Energy demand for heating	PD+TR
Energy for heating	Cooling	Heat loss calculations
Energy for hot water	Ventilation	Energy demand for heating, cooling and hot water
Energy for cooling	Humidity adjustment	Calculations of building ventilation and lighting, BEEC
Energy for ventilation	Hot water	Energy audit
Energy for humidity adjustment	Lighting and others	Information from material and equipment manufacturers
Energy for shared area lighting	Price of energy	Energy supply rates (power, gas, solid fuels)
Other energy consumption in apartment units		Price trends, expert estimates
Other energy consumption in shared areas		Experience from similar projects Legislation and standards in force
<b>OC2</b>		
Drinking water and wastewater	Water demand	PD+TR
Water charges	Water and sewerage charges	Water demand calculations, Water and sewerage charges as per project location, Price trends, Legislation and standards in force
Sewerage charges		
<b>OC3</b>		
Waste disposal	Waste quantities and types	PD+TR
	Number of persons producing waste	Binding local municipal ordinances
	Waste collection charges	Waste collection company's terms and conditions Expert estimates Experience from similar projects Legislation and standards in force
<b>OC4</b>		
Cleaning	Cleaning extent and frequency	PD+TR
	Sizes of areas	Cleaning company's quotations or wage cost estimate
	Surface materials	Experience from similar projects
	Expert estimates	Legislation and standards in force
	Price of cleaning	
<b>OC5</b>		
Greenery maintenance	Scope of maintenance	PD+TR
	Sizes and types of areas maintained	Company's quotations or wage cost estimate
	Price of maintenance	Expert estimates Experience from similar projects Legislation and standards in force
<b>OC6</b>		
Building guarding and security	Method and scope of security arrangements	PD+TR
	Prices	Company's quotations or wage cost estimate Expert estimates Experience from similar projects Legislation and standards in force
<b>OC7</b>		
Building and property insurance	Property type and use	
Property insurance	Roof shape	PD+TR
Other insurance	Number of floors	Insurance company's quotations
	Total floor area	Expert estimates
	Equipment	Experience from similar projects
	Specific requirements	Legislation and standards in force
<b>OC8</b>		
Administration and servicing charges	Land and built-up area sizes	PD+TR
Property tax	Property location	Local municipal coefficients (tax)
Inspection and servicing charges	Number of floors	Servicing and inspection company's quotations
Other charges	Property electric and gas equipment	Expert estimates
	Elevators	Experience from similar projects
	Boiler room type and other equipment	Legislation and standards in force

documentation is being made (documentation for building permit, project execution documentation, including tendering documentation, implementation documentation and as-built documentation) and specific structural, technical and material solutions are designed, including all equipment. According to the legislation, a building energy

efficiency certificate has to be produced, informing about the energy demands of the building. Specific fixtures and fittings for the building are selected as well as suppliers and manufacturers. The operating cost identification can make use of information from the project documentation and technical reports as well as from the selected

Table 3: Sources of data and information for identification of operating costs in operating phase

Operating Costs (OC)	Operating phase	
	Required information	Information sources
<b>OC1</b>		
Energies	Energy consumption	Records on actual energy consumption
Energy for heating	Price of energy	BEEC
Energy for hot water		Invoices from energy suppliers
Energy for cooling		Price trend estimates
Energy for ventilation		Legislation and standards in force
Energy for humidity adjustment		
Energy for shared area lighting		
Other energy consumption in apartment units		
Other energy consumption in shared areas		
<b>OC2</b>		
Drinking water and wastewater	Water consumption	Records on actual water consumption
Water charges	Water and sewerage charges	Invoices from water suppliers (local water and sewerage utility)
Sewerage charges		Price trend estimates
		Legislation and standards in force
<b>OC3</b>		
Waste disposal	Number of persons producing waste	Records on actual waste collection expenditures
	Waste quantities and types	Amendments to legislation in force
	Waste collection charges	
<b>OC4</b>		
Cleaning	Cleaning extent and frequency	Actual costs of cleaning (wage and material costs or contract on cleaning services with external company)
	Sizes of areas	
	Surface materials	
	Price of cleaning	
<b>OC5</b>		
Greenery maintenance	Scope of maintenance	Actual costs of maintenance (wage and material costs or contract on maintenance with external company)
	Sizes and types of areas maintained	
	Price of maintenance	
<b>OC6</b>		
Building guarding and security	Method and scope of security arrangements	Actual costs of building security (wage and material costs or contract on security arrangements with external company)
	Prices	
<b>OC7</b>		
Building and property insurance	Property type and use	PD+TR
Property insurance	Roof shape	Local survey
Other insurance	Number of floors	Current insurance policies
	Total floor area,	
	Equipment,	
	Specific requirements	
<b>OC8</b>		
Administration and servicing charges	Land and built-up area sizes	PD+TR
Property tax	Property location	Current tax assessment
Inspection and servicing charges	Number of floors	Contracts with servicing and inspection companies
Other charges	Property electric and gas equipment	Records on actual expenditures
	Elevators	
	Boiler room type and other equipment	

suppliers of materials and equipment and necessary information can be obtained from the municipal authorities and other institutions of jurisdiction depending on the location and price quotations and other information (cleaning services, greenery maintenance, etc.) can be requested from selected companies.

All the necessary information and real-world data are available after the project completion in the use phase but the ability to influence the operating costs is limited now. The operating cost identification can work with as-built documentation and all the technical and inspection reports, contracts with external companies providing the required services (facility management, cleaning, greenery maintenance, guarding, etc.); Records of actual energy and water consumption and real-world data on expenditures are also available. All the information for

identification of the actual operating costs is available before a planned renovation or cost optimisation; Information for alternative options has to be identified similarly to the design phase (Anonymous, 2003, 2004, 2005, 2007a, b, 2008).

In the operating phase, we can compare the operating costs planned in the design phase with the actual costs. The difference between the operating costs may be due to errors in the project documentation, wrong execution of the building or its parts by the contractor, changes in user's behaviour, legislative changes, climate change, inappropriate use of equipment, etc. Some of the causes of changes in the operating costs can be avoided (quality of building execution, errors), others have to be considered but cannot be influenced (climate change or legislation changes). Operating costs require meticulous

attention due to their amount throughout the building's life cycle. The cardinal focus on minimising operating costs should take place in the pre-investment phase of the project: the planning period which offers the greatest room for optimisation. It is advisable to record and monitor the actual costs during the building operation and update and optimise based on that information. For example, the insurance policy should be updated after a certain period to take account of the building's wear or increase in its value over time. An extension or heightening of the building also requires a new property tax return, resulting in a new tax assessment based on the new information. Moreover, heating sources age which reduces their efficiency, increases the energy consumption (building energy intensity) and most importantly, increases the operating costs. Energy costs represent a substantial portion of the operating costs and the current emphasis on assessment of these most significant operating costs had led to such great pressure to reduce energy intensity of buildings that the initial purpose of this study has been partly accomplished by the introduction of mandatory building energy efficiency certificates and amendments to Act No. 406/2000 Coll and Executive Decree No. 78/2013 Coll. Therefore, the main attention and contribution of the study focus on the classification and categorisation of the various cost types and methods of identifying them. The study makes a synoptic classification of operating costs into categories and a detailed description of the various types of operating costs, specifies instructions for identifying them and presents a methodology for identification of operating costs in the constituent phases of a building's life cycle (Capova *et al.*, 2006; Gundersen, 1998; HM Treasury, 2011).

### CONCLUSION

Buildings have a long life cycle which is why any improvement in techniques of assessing them when selecting the best option will significantly reduce their future environmental impacts and move them towards sustainable development.

Energy costs offer the greatest saving potential. Energy-saving measures leading to reducing energy consumption are also related to the highest expenditures of capital investment be it replacement of a heating and hot water source or replacement of windows or thermal insulation of the building envelope. Cost-saving measures may be low-cost or cost-free as well. They may not bring such significant savings as high-cost measures but they require zero or very low investment and will result in a cost reduction. It is important to choose an appropriate combination of cost-saving measures to ensure a

reasonable rate of return on investment. No general formula for calculating the relation between capital and operating costs can be provided; every project requires individual assessment but the study proposes effective ways of reducing operating costs.

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