Available online at www.sciencedirect.com
ScienceDirect
Omega 36 (2008) 429–441
omega
The International Journal of Management Science
www.elsevier.com/locate/omega

Evaluating the life cycle of a building: A multivariant and multiple criteria approach☆

Nerija Banaitiene[a], Audrius Banaitis[a], Arturas Kaklauskas[a], Edmundas Kazimieras Zavadskas[b,*]

[a]*Department of Construction Economics and Property Management, Vilnius Gediminas Technical University, Sauletekio 11, LT-10223 Vilnius-40, Lithuania*
[b]*Department of Construction Technology and Management, Vilnius Gediminas Technical University, Sauletekio 11, LT-10223 Vilnius-40, Lithuania*

Received 31 January 2005; accepted 11 October 2005
Available online 30 November 2006

Abstract

This paper considers the application of methodology for the multivariant design and multiple criteria analysis of the life cycle of a building. The theoretical basis of the methodology is developed. A proposed methodology allows everyone (i.e. client, investor, contractor, etc.), who has to make the decisions, to design alternatives of the building life cycle and to evaluate its qualitative and quantitative aspects. This approach, in which various criteria can be employed, is intended to support the decision making on a building's life cycle selection and increase the efficiency of the resolution process. The procedure of the evaluating of a building's life cycle is discussed using an example.

Keywords: Multiple criteria analysis; Decision making; Project management; Building life cycle

1. Introduction

The selection of a variant of a life cycle of a building among a vast number of alternatives is an important problem in project management. The selection of a building's life cycle is a decision characterized by multiple objectives. Many participants (client, designer, contractor, etc.) are all involved in the building's life cycle. Clients want to minimize the likely costs of the project, but they also want to achieve highest acceptable quality standards as well as to satisfy technological, architectural, and comfort requirements. Other participants (e.g., designer, contractor) are interested in maximizing profits; they are also concerned with other objectives such as company growth, market share, and the state institutions' interests.

All decisions involve choosing one from several alternatives. Alternatives of a building's life cycle can be generated on the alternatives of the design, construction, facilities management, and final demolition processes. Alternatives of a building can be designed on the structural components, construction materials and methods. The problem is to choose an 'optimal' life cycle of a building according to the needs of various parties

☆ This paper was processed by Guest Editors Margaret M. Wiecek, Matthias Ehrgott, Georges Fadel and José Rui Figueira.

* Corresponding author. Tel.: +370 5 2745002; fax: +370 5 2700114.
E-mail address: Edmundas.Zavadskas@adm.vtu.lt (E.K. Zavadskas).

0305-0483/$ - see front matter © 2006 Elsevier Ltd. All rights reserved.
doi:10.1016/j.omega.2005.10.010

involved. Multiple criteria methods are available for evaluation of a building's life cycle alternatives. Multiple criteria optimization is a process of determining a feasible solution for the decision maker according to the established criteria (e.g., a set of the quantitative and qualitative criteria).

In this paper, the authors present a methodology that allows decision maker to reach a decision by designing alternatives of a building's life cycle and to evaluate criteria both qualitative and quantitative contained in the process. This approach is intended to support the decision making process and increase the efficiency of the resolution process.

The remainder of this paper is structured as follows. Section 2 discusses with the building's life cycle problems and their solution processes. Section 3 presents the methodology for the multivariant design and multiple criteria analysis of a building's life cycle. An example is given in Section 4 to illustrate the use of the methodology. Finally, some concluding remarks are provided in Section 5.

2. Building's life cycle problems and solution processes

Research being done generally into a building's life cycle aims to increase its efficiency and may be classified under the problems they solve:

- problems of a particular phase of a building's life cycle from concept to demolition;
- certain problems throughout the building's life cycle;
- increase of the efficiency of a building's life cycle; and
- use of information technology to increase the efficiency of a building's life cycle or one of its particular phases.

Zavadskas et al. [1] presented an analysis on the modeling and forecasting of housing credit access by applying methods of multiple criteria analysis. Ginevicius and Andruskevicius [2] analyzed the planning of real estate guarantee service costs by applying correlative-regressive analysis.

In order to evaluate the overall efficiency of a project it is necessary to identify selection criteria, to assess information relating to these criteria, and to develop methods for evaluating the criteria to meet the participant's needs. Decision analysis is concerned with situation in which decision maker have to choose among several alternatives through the consideration of a common set of criteria. Ling [3] determined a system of criteria that may affect an architect's/engineer's performance, and constructed a model to predict the performance in design/build projects. Several researchers, such as Hatush and Skitmore [4], Ng and Skitmore [5], Palaneeswaran and Kumaraswamy [6], and Wong et al. [7] identified common criteria for prequalification and bid evaluation for contractor selection. Opricovic and Tzeng [8] state that after generating and evaluating the alternatives, the multiple criteria decision making (MCDM) methods could be applied to rank alternatives and to propose a solution to the decision maker. For a survey of MCDM methods see Zanakis et al. [9], and for applications in the construction context Kvederyte et al. [10], Zavadskas [11], and Zavadskas et al. [12,13].

With the coming up of project management, much attention is now devoted to contractor selection. Skitmore [14] analyzed the identification strategies of outliers of construction contract auction. Hatush and Skitmore [4] presented a multiple criteria decision analysis technique for contractor selection and bid evaluation based on utility theory. The proposed technique may also be used for the selection of construction equipment, and the selection of construction and project managers. Cheung et al. [15] developed a hierarchical model of alternative dispute resolution process attributes. The analytical hierarchy process methodology and experts knowledge were employed to prioritize the critical attributes.

Banaitis [16] developed an analytical complex analysis model of rational housing. The suggested complex system of indices allows evaluating the trends of the housing policy and activities on a global-scale, and the housing in countries of different economic development. Del Cano and de la Cruz [17] presented the project risk management methodology that has been particularized for construction projects from the point of view of the owner. The methodology can also be adapted to the needs of a contractor or other project participant. Kalay et al. [18] consider, that the quality of the overall project can be improved (in terms of time, money, and quality of design) if there was a tighter collaboration among the participants (owners, financial institutions, architects and engineers, etc.). Researchers developed an integrated design model, which is intended to support such collaboration.

Azar and Hauglustaine [19] proposed the multiple criteria decision aid methodology and the linked software AMCE to optimize the building envelope about cost and energy performance, during the sketch design. Meszek and Thiel [20] proposed the utility additive multiple criteria method and the linked software PREFCALC for assessment of the economical and