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The Use of Life Cycle Techniques in the Assessment of Sustainability

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Abstract

After a period characterized by a strong emphasis on the environmental and physical aspects of construction processes, researchers are speeding up efforts to combine environmental performance with economic data. The driver of this movement has been the challenge of establishing a balance between the three main pillars of sustainable construction; namely the social, economic and environmental dimensions. Life Cycle Costing (LCC) has long been recognized as an important technique for the evaluation of the total cost of ownership from cradle to grave and it has frequently been used in decision making processes in construction. Life Cycle Analysis (LCA) on the other hand, measures the environmental performance; in other words the consumption of natural inputs and emissions to nature by production processes. However, the difficulties faced in the implementation and integration of life cycle methods raise concerns over the ability to meet all objectives of sustainability including the social dimension. Practical difficulties encountered in the collocation of existing tools, their structural differences, theoretical concerns, efforts to alleviate these problems and the extent to which LCC and LCA techniques may fulfil the requirements of sustainable construction are discussed. The study is expected to enhance our understanding of life cycle sustainability assessment concept and the extent to which existing tools can be integrated.

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1. Introduction

Construction industry is one of the major consumers of energy and natural resources. According to UNEP SBCI (2009), buildings consume approximately 40% of global energy and consequently are responsible for one third of annual gas emissions in the world. The term 'sustainability' entered into construction industry in mid-1990's upon

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greater awareness on the impact of the industry on our planet. Although first attempts to include sustainability in building production focused solely on environmental factors, through time, economic and social pillars of sustainability have also been incorporated in the assessment of buildings.

One of the main tools utilized to include economic factors in the assessment of sustainability is the Life Cycle Costing (LCC) methodology. LCC is used to compare alternative design strategies based on initial, maintenance and operational costs incurred over a specified period of time. Despite the fact that investment efficiency is the main goal of LCC, efforts to use this technique in environmental decision making have attracted the attention of many researchers. As a result, several research projects have been initiated to incorporate LCC in environmental decision making. However the adoption of such holistic approaches has been limited in the building sector due to the challenges associated with the inability to include environmental costs in LCC calculations (Gluch & Baumann, 2004). Therefore, it can be stated that LCC basically provides the most cost effective solution, not necessarily the most environmental friendly option.

Life Cycle Analysis (LCA) on the other hand is another widely recognized decision making support tool that is considered for solely evaluating the environmental load. LCA aims to evaluate the potential environmental impacts of a product or a process during the entire life cycle. Similar to LCC, LCA studies for buildings may be concerned with the whole building or its constituent parts such as materials or components. Most of the studies undertaken in building LCA literature falls into the latter category.

The identification and assessment of social aspects in life cycle calculations are often reported to be challenging due to the diverse nature, the variety of stakeholder groups effected by them and the tendency for a greater change in time compared to environmental aspects (Griesshammer et al., 2006). Therefore, few studies have focused on a comprehensive assessment of buildings that combine social aspects with environmental and economic data. However, this is an important deficiency in the building research arena, as the term "sustainability" stands on three pillars and all aspects should be considered concurrently in decision making in order to reach meaningful results.
Based on this shortcoming, the two main objectives identified for this study are;

- to undertake a review of the use of economic, environmental and social life cycle studies for construction and
- to explore the difficulties faced in the unification of three pillars of sustainability in life cycle sustainability studies.

2. LCC

LCC aims to evaluate the cost effectiveness of alternative design strategies by considering the potential initial and operational costs that will be incurred over a specified period of time. Only values that can be expressed in monetary terms are taken into account in LCC calculations; thus intangible impacts such as comfort and environmental load are neglected.

The use of LCC calculations in construction projects started to become more important with the increased awareness on the significance of operational and maintenance costs of buildings and the growing "value for money" trend. According to Flanagan (2005), the operational and maintenance costs of an office building in 25 years will be threefold over its initial costs. Sustainability aspects and the rise of the project finance model has furthermore caused LCC techniques to come to the front. However still, problems associated with the lack of standardized data on cost, performance and uncertainty in the prediction of future costs exist.

The LCC process is governed by the ISO 15686 standards (ISO 15686-5, 2008). However, the methodologies used for LCC in construction are several. Therefore in 2006, the European Commission appointed Davis Langdon Management Consulting to develop a common methodology for construction projects. The final report was published in 2007 (Davis Langdon, 2007) and the proposed methodology is intended to be compatible with ISO 15686, part 5. The first two steps in the report are to identify the main purpose and scope of LCC study according to the expected outcomes. The third step includes the identification of the extent to which sustainability and specifically environmental analysis relates to LCC. The identification of an appropriate study period is the next step in the report. Factors such as the design life, economic interest and projected refurbishment/remodeling periods are deemed important in the selection of an appropriate period. Davis Langdon (2007) furthermore points out that the analysis period and the discount rate used are closely related and should be selected very carefully as these decisions