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Cost-benefit prediction of green buildings: SWOT analysis of research methods and recent applications

M. Khoshbakht [a]*, Z. Gou [a], K. Dupre [a]

[a] *Griffith University, Gold Coast, QLD 4215, Australia*

Abstract

In the literature, there is a great variation in the cost-benefits due to the differing methodologies used in the estimation. This study aims at presenting a literature review of cost-benefit prediction methods combined with a SWOT analysis, particularly emphasising data collection and analytical approach. Findings show that the methods used in green building cost-benefit studies can be grouped into different categories in terms of data collection and analytical approach. Each method has its advantages and disadvantages with divergent capabilities. This literature review revealed that much of the current cost-benefit research lacks validity and reliability, and has different degrees of bias.

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Keywords: Green cost-benefits; empirical surveys; simulations; meta-analysis; paired comparisons; unpaired comparisons; baselines and standards; SWOT analysis.

Nomenclature

SWOT	Strength, weakness, opportunity and threats
WLC	Whole life cycle
LEED	Leadership in Energy and Environmental Design
IAQ	Indoor air qualities
IEQ	Indoor environmental qualities

* Corresponding author. Tel.: +61-755-527-529; fax: +61-755-527-530.
E-mail address: m.kh@griffithuni.edu.au

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1. Introduction

1.1. Background knowledge

In recent decades, there has been a growing concern regarding environmental issues, and consumption of energy and resources in the building sector. Green buildings or sustainable developments are a response to growing environmental concerns. Yudelson [1] defines green building as "A high-performance property that considers and reduces its impact on the environment and human health". Yet, green architecture developments seem to encounter several impediments and barriers. Gou et al. [2] mentioned some of the major topics in green building market readiness and some cost-related barriers such as higher initial design and construction costs, extra costs of searching for green alternatives and certification processes, a long payback time of 20 years and a difficulty of defining quantifiable requirements during the procurement process. The extra costs and related risks of green design technology may discourage initial investors from commitment to green attributes [2]. Hwang and Tan [3] indicated that the ambiguity of the real costs and benefits is a major impediment to the development of green buildings.

Cost-benefit analysis is a quantitative economic analysis method which evaluates profitability and return of investments for alternative design options [4]. Similarly to traditional financial strategy and performance measurements, green cost-benefit studies examine the correlations between green strategies and green performances to discover relationships between costs and benefits for decision making. In green building studies, the relationships between green strategies and building performances are examined to verify the existence and strength of the link among certain variables, such as natural ventilation strategies and thermal comfort performances. Cost-benefit studies, though, aim to identify relationships among green costs as a consequence of green strategies and benefits as a consequence of green performances. In other words, the extra costs of green buildings are evaluated against the extra financial benefits. Figure 1 illustrates both the relationships between strategies and performances found in green research studies, and the relationships between costs and benefits resulted from cost-benefit research studies. An example of the mentioned relationship studies is the cost-benefit analysis of indoor environmental qualities (IEQ) and employee productivity [5-7]. The quality of working environments and comfort has a great influence on occupant productivity and well-being [8]. Higher employee productivity means higher financial benefits for companies [9]. Yet, monitoring and management of IEQ using sensor devices and other control strategies require purchases of equipment and higher building management fees. In a cost-benefit analysis, the extra costs are evaluated against the financial gains resulting from higher employee productivity.

In general, costs of green buildings can be divided into two categories: pre-construction costs and post-construction costs. Pre-construction costs include soft costs and hard costs. Soft costs are the costs related to design, commissioning, and documentation fees [10]. Hard costs are construction, materials, and building services costs [1]. Post-construction costs are building operating costs of energy consumption, water use, maintenance, and management. Benefits though, include differing savings and financial gains during building construction and post-construction phases such as higher property market value, higher rents, fewer vacancies, marketing opportunities resulting from social benefits, lower carbon taxes, higher energy savings, less sick leave, and higher productivity. However, it is important for a researcher to identify the link between interests of stakeholders and cost-benefit evaluations. Bordass [11] reported on the different interests of stakeholders with regard to cost variables during the whole life cycle (WLC) of green buildings. He indicated that for developers, who pay for land, design and construction costs, only the market value at the time of the project completion is important. In addition, green building labelling matters for developers, since it raises the marketing opportunities. Institutional investors, on the other hand, are interested in all cost variables except the running costs. However, Bordass also showed that many institutional investors care about energy savings to have longer leases and keep good tenants happy. For owner-occupiers, all the related costs are important, including the market value at the time of the purchase and in the future. Tenants, though, are only interested in running costs and benefits such as energy savings, maintenance and management costs, productivity, health and social benefits such as public relations. The interesting point here is that energy savings, health and productivity gains are not directly important for the initial investors. Overall, it could be said that the accumulation of diverse cost-benefit variables is imperative for a full package of economic evaluations, and that it should be communicated to various stakeholders in the green building industry.