Building and Environment 46 (2011) 1081–1086

Contents lists available at ScienceDirect

Building and Environment

journal homepage: www.elsevier.com/locate/buildenv

Cost premium prediction of certified green buildings: A neural network approach

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ARTICLE INFO

Article history:
Received 11 August 2010
Received in revised form
11 November 2010
Accepted 16 November 2010
Available online 25 November 2010

Keywords:
Sustainable construction
Green buildings
LEED
Cost
Artificial neural network
Regression

ABSTRACT

Built environment has a substantial impact on the economy, society, and the environment. Along with the increasing environmental consideration of the building impacts, the environmental assessment of buildings has gained substantial importance in the construction industry. In this study, an artificial neural network model is built to predict cost premium of LEED certified green buildings based on LEED categories. To verify the viability of the model, multiple regression analysis is used as a benchmarking model. After validating the prediction power of the neural network model, a global sensitivity analysis is utilized to provide a better understanding of possible relationships between input and output variables of the prediction model. Sustainable Sites and Energy & Atmosphere LEED categories were found to have the highest sensitivity in cost premium prediction. In this study, our goal was to reveal the significant relationships between LEED categories and the cost premium, and offer a decision model that can guide owners to estimate cost premiums based on sought LEED credits.

1. Introduction

The construction industry has a significant impact on the environment, economy, and society. Buildings are one of the biggest contributors to greenhouse gas emissions; for which they are responsible for 38% of all CO_2 emissions [1]. Increased awareness of the enormous ecological footprint of the build environment has substantially increased the importance and popularity of various green building initiatives as a possible solution to remediate the damages incurred on the planet. Many of these initiatives focus on enhancing biodiversity, improving air and water quality, reducing solid waste generation, and conserving natural resources of buildings. These initiatives are changing the construction industry and increasing the share of the green building market significantly [2]. The value the overall green building market is estimated to be $36 billion to $49 billion with an anticipated market value of $96 billion to $140 billion by 2013 [3]. As of September 2009, commercial buildings certified with *The Leadership in Energy and Environmental Design* (LEED) green building rating system in USA reached to the number of 3855 and accounted for 613 million square foot in total [4].

Along with these market values and increasing trend of the green construction practices, the green market has been promoted to bring major improvements through employing green building practices. Primary drivers cited in the literature for green building adoption include minimizing operating and maintenance costs, increasing employee health, productivity, and satisfaction, and improved indoor environment quality [2,5]. For instance, some green buildings were reported to consume 26% less energy and have demonstrated 13% lower maintenance cost when compared to average commercial buildings [6]. These benefits come with a cost, and with lower first-costs that are competitive with conventional buildings, the attractiveness of green buildings will significantly improve [7]. This is especially true, since the construction firms still perceive that green buildings cost significantly more than their conventional counterparts [2]. But, even if the project is finished with a budget comparable to its conventional alternative, certain project costs would still be correlated with specific green strategies. In this paper, we are concerned with identifying the relationship between the cost premium of green buildings and LEED credits utilizing artificial intelligence techniques to aid decision makers in selecting their green strategies.

Few decision models are found in the literature that specifically target green buildings. Castro-Lacouture et al. [8] proposed a mixed integer optimization model that maximizes LEED credits attained while considering design and budget constraints. Wang et al. [9] developed an object-oriented framework that tackles specific problem areas related to green building design optimization. Through their framework, they utilized multi-objective genetic algorithms to explore the trade-off between life-cycle cost and life-cycle environmental impacts in green building design. In another study, Wang et al. [10] developed a methodology to optimize the

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doi:10.1016/j.buildenv.2010.11.009