Research on Economic Evaluation of Green Building Based on Multi-factor Correlation Analysis

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ABSTRACT

With the rapid development of urbanization in our country, the problems of energy consumption and environmental pollution become more and more serious because of constructions. It will be of great significance to promote the development of green buildings as well as establish a set of economic evaluation system for green buildings. At present, most technical and benefit evaluations about green buildings are based on qualitative analysis instead of quantitative analysis. On the basis of green building projects, this study explores factors that affect the cost of green buildings. A correlation analysis is conducted to factors that affect the cost. A multiple regression model is built to assess the degree of greenness of buildings according to Green Buildings Evaluation Standard categories. Error analysis is provided to verify the viability of the model. Verification results show that the evaluation model is of high reliability. As a result, this study can provide a basis for scientific judgment of the economic evaluation for green buildings.1

KEYWORDS

Green Building; Economic Evaluation; Multi-factor Analysis; Model

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INTRODUCTION

Under the rapid development of urbanization in our country, the construction industry consumes more and more energy resources and causes more and more destruction to the environment. It will be of great significance to promote the development of green buildings as well as build an economic evaluation system for green buildings [1].

With the development of green buildings, many scholars have done research and analysis on the economy of green buildings[2-4].

Although, the scholars home and abroad have put forward a lot of green buildings evaluation methods and systems, there are many factors affecting green buildings[5]. It is difficult to meet the green building evaluation requirements mainly by using qualitative methods with single factor to analyze technical and economic benefits of buildings. According to 42 green buildings as samples, this paper studies the factors affecting green buildings economic cost and analyses the relation between green buildings cost, the number of layers and the area by numerical nonlinear analysis method quantitatively[6]. It also constructs the green buildings evaluation model with linear regression method and analyses the impact weight coefficient of building layer and area on green building cost by using SPSS.

THE DATA COLLECTION ANALYSIS OF GREEN BUILDINGS

According to 42 high-rise as analysis samples in Hubei province including 14 one-star projects as same as two-star and three-star, this paper studies impact weight of “four savings” investment.

The building area is from 3.8*10^4 m^2 to 70.93*10^4 m^2. The building story is from 6 to 52. The building cost is from 2003.34 to 3247.14 yuan per m2. The non-green building cost in a one-star project is from 1989.78 to 3200.41 yuan per m2. The non-green building cost in a two-star project is from 1945.40 to 3005.24 yuan per m2. The non-green building cost in a three-star project is from 1918.29 to 3083.24 yuan per m2.

The technical costs of green buildings of different ranks vary. Applying rain collection and water-saving equipment accounts for the main cost of one-star building projects instead of arising energy efficiency and the cost every square meter in green technology methods is RMB 33.41. Two-star green buildings pay more attention to energy efficiency and new energy exploitation and improving the utilization of non-traditional water sources than one-star buildings. The cost every square meter in green technology methods is RMB 78.28. More technology investments have been made on energy saving, water saving, ground saving and material saving for three-star green building compared to two-star especially on energy saving and material saving. And the cost every square meter for green building is RMB 143.32.
The three-star green building cost is distributed on the top drawer, then is the second-star, and the one-star is distributed on the bottom. In addition, the investment of green building is effected by the scale of building. The green building costs on the same star have the tendency to decrease with the increase of the layer number and the area of the buildings. So, the cost of green building is not only affected by the discretion of the star, but also the scale of the building. In this paper, the layer and area of the building are used to represent the scale of the building.

GREEN BUILDINGS COST ANALYSIS

The correlation analysis was conducted according to the principle of statistical analysis. The cost of one-star green buildings is significantly correlated to building area and non-significantly correlated to building layers statistically. The cost of the two-star and three-star green buildings are significantly correlated to building layers and building area.

With the cost of green building project as the dependent variable, the layer number of building and construction area as the independent variables, we can establish the multivariable linear regression mathematical model of the cost estimation of green building. We use the least square method to calculate the regression coefficient $\beta$ and establish a linear regression mathematical model. It indicates that regression coefficient is significant on the whole and the regression mathematical model can be used to predict.

The statistic $T_j$ follows the t-distribution of the degrees of freedom for $n - m - 1$. We use the statistical magnitude D-W to check the error term is independent. We import the data of 42 samples which is classified by SPSS and standardize the data. Then we place green building cost as the independent variable, the layer number and the area as dependent variables for linear regression.

The incremental cost estimation of each star level are as follows:

$$\Delta C = f(N,S,i) = \begin{cases} 48.919 + 0.217*N - 0.724*S; i = 1 \\ 110.056 - 0.742*N - 0.279*S; i = 2 \\ 200.287 - 1.262*N - 0.813*S; i = 3 \end{cases}$$

(1)

The residuals of sample values and predicted values still need to be analyzed after the cost estimation models of green building projects have been determined and the goodness of fit of the model and the significance of regression coefficients are statistically significant. The relative error is as follows:

$$\epsilon = \Delta C_r - \Delta C$$

$$\Delta \epsilon = (\frac{\Delta C_r - \Delta C}{\Delta C}) \times 100\%$$

(2)

(3)
Where $\Delta C$ is the predicted cost, is the error value, $\Delta Cr$ is the actual cost of green buildings.

Through error analysis, we find that the error values between actual costs and predicted costs of one-star green buildings are mainly within $\pm 15\%$, two-star and three-star green buildings are mainly within $\pm 10\%$.

**CONCLUSIONS**

Green building is a complex system of social, economy and environment with the characteristics of energy efficient, water efficient and material efficient. It is a path of sustainable development to achieve the coordination of environment, economy, ecology and social benefits. Consequently, it is essential to establish a set of evaluation system for green buildings suitable for the development of China.

Based on the statistical analysis technique, this paper makes a technical and economic analysis on the green building, explores the influencing factors of the green building, and determines the relationship between the weight of the influencing factors and the star level. Based on the correlation analysis and linear regression analysis method, SPSS was used to construct the economic evaluation model of green building and verify the accuracy of the model via F-test, T-test and error analysis between actual values and predicted values. The results show that the model has the advantages of small error and high precision, which can provide foundation for decision-making for the economic evaluation of green building projects. By helping investors choose the best options, it will drive green buildings to the market and speed up the popularization and promotion of green buildings.

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