

Model for analyzing the relationship between cost of energy-saving and construction

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Abstract. In the analysis of the relationship between the cost of energy-saving and construction, since the traditional analysis method is too simple, a comprehensive and detailed analysis for the rationality of the relationship between the cost of energy-saving and construction cannot be conducted, lead to high costs for construction. To solve this problem, an analysis method for the relationship between the cost of energy-saving and construction is proposed based on the cost estimation of energy-saving construction. To start with, from the perspective of the building energy saving to describe the constitution of the energy-saving cost of the building, analyze the relevance of the cost of energy-saving and construction, by establishing the dialectical relationship among the energy-saving investments of construction, the energy-saving utilization cost of building and the cost for the life cycle, to achieve the goal of establishing a reasonable analysis model for the relationship between the cost of energy-saving and construction. The simulation demonstrated that the proposed cost estimation method for energy-efficient buildings utilized for analyzing the relationship between the cost of energy-saving and construction, have high accuracy and strong rationality.

Introduction

The process of constructing requires to consume large amounts of different types of energy, energy-saving construction is an important issue in current energy field. Nowadays, by energy-saving construction, many buildings save energy and improve the indoor comfort, not only have good economic benefits, but also a good social benefits, and reduce the pollution of the atmosphere at the same time[1.2]. Thus, how to better analyze the relationship between cost of energy-saving and construction is the issue concerned by the industry. The current analysis method is too general, a comprehensive and detailed analysis for the rationality of the relationship between the cost of energy-saving and construction cannot be provided, lead to high costs for construction [3.4].

To solve this problem, an analysis method for the relationship between the cost of energy-saving and construction is proposed based on the cost estimation of energy-saving construction. To start with, from the perspective of the building energy saving to describe the constitution of the energy-saving cost of the building, analyze the relevance of the cost of energy-saving and construction, by establishing the dialectical relationship among the energy-saving investments of construction, the energy-saving utilization cost of building and the cost for the life cycle, to achieve the goal of establishing a reasonable analysis model for the relationship between the cost of energy-saving and construction. The simulation demonstrated that the proposed cost estimation method for energy-efficient buildings utilized for analyzing the relationship between the cost of energy-saving and construction, have high accuracy and strong rationality [5.6].

Establishment of the model for analyzing the relationship between cost of energy-saving and construction

2.1 The description of the relationship between cost of energy-saving and construction

The relationship between cost of energy-saving and construction means to achieve the goal of energy-saving, additional construction cost needs to be added on the basis of the general non-energy-saving cost of building, the following two categories can be considered:

1. Added cost of materials, equipment, finished products, semi-finished products and other

Compared with non-energy-saving construction, the envelope structure of energy-saving construction needs to be increased, because the improvement of heat preservation and heat insulation performance need to increase or improve costs of materials, finished products, semi-finished products related to their performance; heating or cooling performance and energy efficiency of heating or cooling system have to be improved, which means the acquisition cost of the related equipment need to be augmented; purchase costs of the equipment for new renewable energy is also needed, these costs are generally higher, but that's the main part of the cost of energy-saving building.

2. Added cost of design, construction, testing, management and other

Energy-saving construction project is a systematic project, which needs the mutual collaboration and cooperation of all relevant parts, departments, and each sector of construction, in addition to the construction and installation of materials and equipment of the constructed unit, energy-saving calculation and design of the unit need to be designed, and test and inspection for energy-saving materials and energy-saving effect have be conducted by quality inspection departments, also the relevant sectors including construction group have to involve in management of energy-saving construction. In addition, to ensure the effect of energy-saving construction, within the operating life of the building, envelope structure and related equipment are in need of repair and maintenance, which motivate the boosting of the cost

2.2 Factors Affecting cost of energy-saving and construction

The aim of using construction cost estimation to analyze the cost of energy-saving construction, is to explore the ways and methods to reduce the cost, to begin with, we must identify the various factor affecting the cost of energy-saving construction.

1. The price of energy-saving materials, equipment, finished products and semi-finished products is the main factor affecting the cost of energy-saving construction, the higher the price, the greater the cost of energy-saving.

Since the energy-saving construction cost closely linked to the price is capital expenditure of the cost of energy-saving, these two have linear relationship, in order to enhance the comparability of prices, it have to be emphasized that whether it is the same or different type of materials, equipment, finished products and semi-finished products, the price should be for the object with the same insulation performance or effect, and it have to be the qualified products meet the relevant building energy-saving standards requirement of nation or province. For example, facades of the building equipped with different kinds of materials, such as insulation mortar or extruded panels, multilayer and thicker insulation mortar are necessary to achieve the same or similar thermal insulation effect to extruded panels with better insulation.

2. Types of construction materials and equipment have many choices like all other components, including envelope structure materials of different types of energy-saving and energy-saving devices.

In terms of materials, such as roofing insulation layer, loose granular material is applicable, such as expanded perlite, slag and so on; insulation sheet is applicable as well; the weaknesses in envelope structure of energy-saving construction is window, there are various types of windows, aluminum alloy with broken insulation, steel windows and the window treated with different insulation coating. There are many types of device for heating or cooling energy-saving system and new renewable energy utilization. In practice, such as external walls, insulation material practice is not unique, the blocks or panels with porous structure of double functions like supporting and insulation can be adopted, for roofing, in addition to the use of external insulation sheet, overhead double-insulated roof can also be utilized, which improves both insulation and waterproof effect. Different materials and practices, involving different manufacturers, different production processes, etc., there are significant differences in their cost; in addition, there are various types, selection and performance for the related device to choose, this undoubtedly have affected the energy-saving cost of building.

3. The operating life of the equipment and material.

Because the construction has the requirements for designing operating life, whether the operating life of energy-saving materials, equipment, finished products and semi-finished products is consistent with the building is an important factor for consideration in calculating the cost of energy conservation. If the energy-saving materials, equipment, finished products and semi-finished products are unable to reach the requirement for operating life of building design, it may need to be replaced once or more times in the operating life of the construction, such as the plastic discoloration and aging period of steel windows installing with insulating glass is about 20-30 years, due to the current plastic production technology and production level. While, aluminum windows with broken insulation have 50 years' operating life, is similar to the operating life of the general house, although the prices vary for them, but when calculating the cost, price and operating life should both be taking into account.

The energy-saving cost estimation for the construction within operating period should consider the following aspects:

1. The energy-saving costs is added to the original cost on the basis of meeting the requirements, including the increased cost of materials, equipment, finished products, semi-finished products and design, construction and other aspects.

2. The operating life of envelope structure and energy-saving equipment, and compared with overall design life.

3. Considering the operating life of energy-saving materials of wall, roof, floor, doors and windows of envelope structure, and heating or cooling system, new renewable energy equipment may vary, so the calculation have to be conducted for individual, and then superimposing.

$$s = k_1c_1 + k_2c_2 + k_3c_3 + \cdots + k_ic_i \dots + k_nc_n = \sum k_ic_i \quad (1)$$

Where, s represents the energy-saving cost of the building within operating life (million), k_i , expressed as the coefficient for operating life of energy-saving materials or equipment, the value is the ratio of the designed life of the building to actual operating life of materials and equipment, $c_1c_2c_3 \dots c_n$ expressed as itemized energy-saving envelope structure and related equipment (or increase costs) costs (million).

In summary, with the energy-saving construction cost estimation method to analyze the relationship between construction costs and energy-saving cost, the steps can be summarized as follows;

1. Implementing the measure to reduce the cost of energy conservation

There are a variety of energy-saving insulation materials and equipment for the building, under the premise of meeting the energy-saving standards, preference should be given to those materials, equipment and finished products, semi-finished products of cost-effective, in order to reduce the cost of energy-saving and improve the efficiency.

2. Comparison of planning

With the development and progress of building energy-saving technologies, materials and equipment, the mode and method for energy-saving building also tends to be diversified. Therefore, the choice of energy-saving planning has become an important measure for cost reduction.

The choice of properties, number of layers, the thickness of material are important, the planning have to be compared at both technical and economic aspects, the designing plan which can meet the requirements of energy-saving standards, helps to reduce the cost of energy-saving and improve the efficiency of energy-saving is preferably chosen to be implemented.

3. To adopt a comprehensive energy-saving measures

Building energy efficiency should adopt comprehensive measures, such as the use of the sun louver combining with building facade in the building envelope, the use of hollow wall in the wall structure, the selection of interior decoration and the curtains, ceiling and interior surfacing materials which is consistent with its beautiful, fitness and also with heat insulation function are considered. In architectural design of the house, the structure and function of housing (such as building earthquake) and the economy of building energy saving are considered, reducing the external walls' turn and the total length of the building, controlling the area ratio of window to wall.

In terms of building energy-saving equipment, the heating or cooling mode, systems and equipment selection and use of energy-consuming equipment usage control are taken into whole consideration, so as to achieve that the measures are matched with related use function of buildings, it can reduce the cost of energy-saving, but also receive a relatively good energy saving effect.

In summary, it is able to prove that the precision of analytical model of the relationship between energy saving cost and construction cost established by using building energy-saving cost calculation is high, and the rationality is strong.

Experiment and simulation

In order to prove the validity of the analytical model of the relationship between energy saving cost and construction cost presented in this paper based on building energy cost saving measurement, it needs for an experiment. In the experiment, it needs to build Visual C ++ 6.0 as the development environment virtual platform. In a virtual environment, using traditional algorithm and the proposed algorithm establish the analytical model of the relationship between energy saving cost and construction cost, and according to the experiment results, the following figure can be obtained:

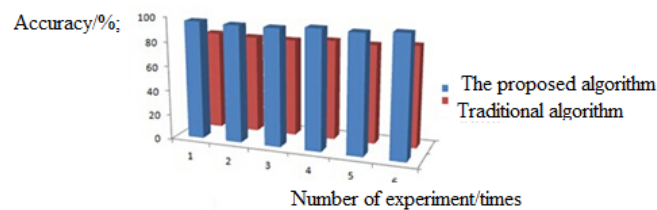


Figure 1. Comparison Chart of the accuracy of different algorithms

According to the above figure, the following table can be showed:

Number of experiment (times)	Accuracy of the proposed algorithm (%)	Accuracy of traditional algorithm (%)
1	96	80
2	95	79
3	95	79
4	97	81
5	96	80
6	98	82

Through the experimental data, it can be explained that the precision of analysis model of the relationship between energy saving cost and construction cost established by using building energy-saving cost calculation is high, and the rationality is strong.

Conclusion

For the problem occurs in the analysis of the relationship between the cost of energy-saving and construction, caused by the traditional analysis method is too simple, a comprehensive and detailed analysis for the rationality of the relationship between the cost of energy-saving and construction cannot be conducted, lead to high costs for construction. To solve this problem, an analysis method for the relationship between the cost of energy-saving and construction is proposed based on the cost estimation of energy-saving construction. To start with, from the perspective of the building energy saving to describe the constitution of the energy-saving cost of the building, analyze the relevance of the cost of energy-saving and construction, by establishing the dialectical relationship among the energy-saving investments of construction, the energy-saving utilization cost of building

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