

## Retraction

# Retracted: Evaluation Algorithm of Ecological Energy-Saving Effect of Green Buildings Based on Gray Correlation Degree

### Journal of Mathematics

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

### References

- [1] C. Wang, "Evaluation Algorithm of Ecological Energy-Saving Effect of Green Buildings Based on Gray Correlation Degree," *Journal of Mathematics*, vol. 2021, Article ID 6705220, 10 pages, 2021.

## Research Article

# Evaluation Algorithm of Ecological Energy-Saving Effect of Green Buildings Based on Gray Correlation Degree

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The environmental protection attribute and energy-saving level of green buildings cannot be described by the traditional evaluation model. In order to solve the above problems, a new ecological energy-saving effect evaluation algorithm of green buildings based on gray correlation degree is designed. Based on the framework of building energy-saving index system, the environmental protection evaluation standards are divided and the results are used to screen the energy-saving indexes, so as to complete the establishment of green building ecological energy-saving index system and standards. Then, the evaluation set is established, and the evaluation scale of each layer of indicators is accurately located according to the weight value of each index. On this basis, the membership matrix is constructed. By calculating the index weight and determining the fuzzy synthesis operator, the rating process of the algorithm is improved and the analysis of the evaluation algorithm of environmental protection and energy conservation indicators of green building materials based on gray correlation degree is realized. The experimental results show that the designed algorithm has good stability of the fitting curve, can save energy, and has low cost.

## 1. Introduction

Energy consumption is large all over the world. Developing green and energy-saving buildings is the only way to reduce building energy consumption [1]. With the wide spread of “green culture,” green buildings have emerged accordingly [2]. The purpose of green building is to give green concept to architecture, connect architecture with sustainable development, and connect architecture with ecosystem. Only by vigorously developing green buildings can we meet the needs of the development of modern urban ecological construction and realize the coordination and unity of man, architecture, and nature. Most construction units use traditional building materials such as cement, concrete, glass, and ceramics [3]. Although these materials have the advantages of good durability and high environmental adaptability, from the perspective of sustainable development, most of these materials belong to nonrenewable resources [4]. Excessive utilization of this type of materials will not only have a serious impact on the total amount of environmental resources, but also make the overall

environmental level show a downward trend year by year. Green materials are the general name of all building materials without pollution. This type of resource material has the application advantages of no pollution, no toxicity, and no radioactivity. With the gradual increase of service life, the building materials after reaching the service cycle can still be recycled, which not only is conducive to the comprehensive implementation of the concept of sustainable development, but also provides a certain guarantee for people’s health. The definition of green building materials mainly focuses on the four links of raw material application, product manufacturing, use, and waste treatment. On the premise of ensuring the rational utilization of materials, how to realize the common development of many concepts such as environmental protection and health on the basis of reducing environmental load has become the primary goal of the construction industry at this stage.

The study in [5] considers water ecological issues and uses monetary valuation to establish a quantitative climate model for urban green buildings. The need to respect environmental factors in terms of resource consumption and

harmful production has led to the formulation of green building regulations. Environmental water attitude was added to Madad's green building model, which is completely developed based on environmental and climatic factors. The model of each city is a function of its climate and population conditions and is implemented according to expert recommendations and analytic hierarchy process (AHP) method. The results of currency valuation research are used to improve the selection of indicators and accurately determine their weight in the model. The index in current research is to reduce runoff, water consumption, and reuse of gray water. The evaluation results of the study area show that only 11% of the green building capacity is used. The study in [6] uses the benefit transfer method to improve the current energy conservation in cooling and lighting in the green building sector in Malaysia. The Malaysian government has shifted from increasing energy supply to meet the demand for reducing energy consumption by promoting green building practices. Malaysia's eleventh plan includes three indicators to monitor the performance of green buildings, including power consumption. Therefore, the study aims to monitor the progress of energy conservation in Malaysia's green building industry by reviewing the current energy conservation performance and quantifying the economic prospect of future energy conservation improvement. It is of great significance to promote Malaysia to become a country with sustainable development through insight into the formulation of future sustainable development roadmap and green building implementation and development strategy. Therefore, residential and industrial buildings in Malaysia have great potential to save energy to the greatest extent. It is strongly recommended that vegetation green envelopes are implemented in green buildings in Malaysia. The study in [7] proposed the governance mechanism for the transformation of building materials industry to green building materials industry from the perspective of green building. Firstly, the evolutionary game theory is used to establish the three-party dynamic game model of building materials enterprises, government, construction developers, and construction consumers. Secondly, based on the model derivation and the theoretical analysis of green transformation, the multistage governance mechanism of green transformation is studied by using numerical simulation experimental algorithm. The numerical simulation results show that the green building infrastructure construction project is an important governance mechanism for the rapid development of GBMI and that the green innovation subsidy is the core governance mechanism for the high-quality development of GBMI. The pollution and fraud compensation punishment for green BME, green innovation subsidy, tax incentive for green BD, and purchase subsidy for green BC are conducive to promoting the transformation of green production and consumption concept. The above mechanisms and infrastructure construction help to promote the production of green building materials in BME through the development and purchase of green buildings. Infrastructure construction and green innovation subsidies play a key role in the high-quality development of GBMI.

Based on the above research, an evaluation algorithm of ecological energy-saving effect of green buildings based on gray correlation degree is proposed. On the one hand, the gray correlation degree is mainly constructed by reflecting the similarity of development process or magnitude between the two sequences. On the other hand, it is constructed by reflecting the similarity of the development trend or curve shape of the two sequences; that is, it mainly describes the proximity of the relative change trend of the ecological energy-saving effect of green buildings between the sequence curves. The research shows that the evaluation algorithm has a good effect on the ecological results of green buildings. In Section 2, the ecological energy-saving index system and the standard of green buildings are established. In Section 3, the proposed evaluation algorithm based on system standard is analyzed. In Section 4, the experimental analysis is carried out. In Section 5, the paper is finally concluded.

## 2. Establishment of the Ecological Energy-Saving Index System and Standard of Green Buildings

Green building ecological energy-saving index system and standard are the application basis of the new evaluation algorithm. With the support of three links: framework construction, grade division, and index screening, the specific establishment algorithm can be carried out according to the following steps.

*2.1. Construction of Green Building Ecological Energy-Saving Index System Framework.* Deeply implementing the architectural concept of people-oriented and harmonious coexistence of man and environment and building an environmental protection and energy-saving index system of green building materials can effectively coordinate the relationship between human economic and social development and ecological and environmental protection. A healthy ecological energy-saving index system of green buildings is the dialectical unity of the natural attribute of ecological environment [8] and the evaluation service attribute. It is not only the material basis for ensuring the good development of ecological environment, but also the key link to promote the rapid development of building environmental protection theory. According to the connotation of the concept of environmental protection and energy conservation [9], a perfect index system should be able to accurately describe the application status, construction environment level, material application direction, expected building effect, and other indicators of green buildings, and each index is an independent individual without being affected by other external conditions. With the support of the above theoretical basis, the framework structure of green building ecological energy conservation index system is shown in Figure 1.

*2.2. Classification of Environmental Protection Evaluation Standards.* The grade of environmental protection evaluation standard is the key index to measure the accuracy of

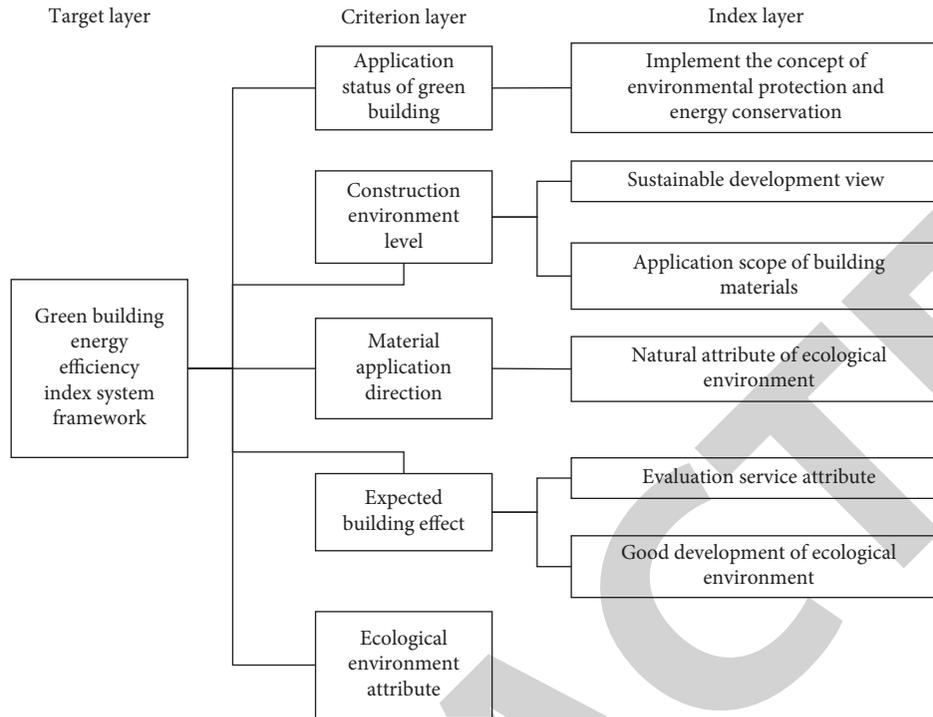


FIGURE 1: Frame structure of the ecological energy-saving index system of green buildings.

green building measurement results. Based on the ecological energy-saving index system of green buildings, the abstract grade index can be transformed into specific environmental protection evaluation standards by comparing the eigenvalues and standard values of the evaluated object in terms of parameter difference. The main source [4], strength and toughness, pollution intensity, pressure bearing capacity, and pricing range of green building materials are selected as the grading variables of the five environmental protection evaluation standards. In the green building ecological energy-saving index system, the above five indexes correspond to one or more frame structures, and there will be no obvious interaction between them. The four indexes of main source, strength and toughness, pollution intensity, and pressure bearing capacity are only affected by the properties of building materials, which belong to the main evaluation grade classification standard. The pricing range is affected by many factors such as season, output, and sales area, which belongs to the secondary evaluation grade classification standard. On the premise of ensuring that green building materials can maintain a low energy consumption level, the classification results of specific environmental protection evaluation standards are shown in Table 1.

**2.3. Screening of Green Environmental Protection and Energy-Saving Indicators.** There are many factors in the evaluation algorithm of green building ecological energy efficiency index, and the interaction between the factors makes the model complex. The construction of the index system cannot be applied to all factor conditions, but the most

representative characteristic indexes that can best reflect the evaluation function of the model are selected. This selection process is the screening of green environmental protection and energy-saving indexes. The new index evaluation algorithm is a composite structure composed of multiple elements, so all the indexes involved must be able to reflect the environmental protection and energy-saving attributes of green building materials independently. In green buildings, energy-saving thermal insulation materials are widely used. Because of the cold climate in winter, the application of energy-saving and environmental protection materials not only has the function of general thermal insulation materials, but also can reduce energy consumption and environmental pollution and has strong market competitiveness. Therefore, the following environmental protection assessment indicators of the model are selected: one level-1 indicator, three level-2 indicators, and 12 level-3 indicators, as shown in Table 2. Due to the different ecological energy-saving thermal insulation materials of green buildings, the selection of evaluation indicators is not fixed, and appropriate indicators need to be selected according to the evaluation focus.

According to Table 2, the principal component analysis method is used to establish the evaluation index set.

The primary indicator set is

$$P = \{p_1, p_2, p_3\}. \tag{1}$$

In (1),  $p_1$ ,  $p_2$ , and  $p_3$  represent the energy consumption, resource consumption, and environmental impact, respectively.

The secondary indicator set is

TABLE 1: Classification of environmental protection evaluation standards.

Division of primary and secondary factors of evaluation	Environmental protection evaluation index	Evaluation criteria and equivalent division results
Main evaluation grade classification criteria	Main sources	Subsidiary indicators affecting the evaluation results of the model
	Strength and toughness	The key index affecting the evaluation results of the model is second only to the pollution intensity of green building materials
	Pollution intensity	The key indicators affecting the evaluation results of the model are much more important than other factors
	Bearing capacity	Subsidiary indicators affecting the evaluation results of the model
Classification criteria for secondary evaluation	Pricing range	On the premise of the change of environmental protection evaluation standards, the pricing range of green building materials also changes

TABLE 2: Selection results of evaluation indicators.

Primary index	Secondary index	Tertiary index
Environmental performance	Energy consumption	Energy consumption
		Energy type
		Energy recovery rate
	Resource consumption	Proportion of energy use
		Raw material consumption
		Raw material recovery
Environmental effect	Raw material reuse rate	
	Raw material substitution ratio	
	Air pollution	
		Water environment pollution
		Solid waste pollution
		Radioactive contamination

$$P_1 = \{p_{11}, p_{12}, p_{13}, p_{14}\}. \quad (2)$$

In (2),  $p_{11}$ ,  $p_{12}$ ,  $p_{13}$ , and  $p_{14}$  represent energy consumption, type of energy, energy recovery rate, and proportion of energy use, respectively.

$$P_2 = \{p_{21}, p_{22}, p_{23}, p_{24}\}. \quad (3)$$

In (3),  $p_{21}$ ,  $p_{22}$ ,  $p_{23}$ , and  $p_{24}$  represent raw material consumption, recovery rate of raw materials, reuse rate of raw materials, and raw material substitution ratio, respectively.

$$P_3 = \{p_{31}, p_{32}, p_{33}, p_{34}\}. \quad (4)$$

In (4),  $p_{31}$ ,  $p_{32}$ ,  $p_{33}$  and  $p_{34}$  represent atmospheric environmental pollution, water environment pollution, solid waste pollution, and radioactive contamination, respectively.

In order to ensure the authenticity of the algorithm evaluation results, the screening of relevant index data must maintain a certain advance, and the official parameters issued by relevant departments shall be applied in data calculation as far as possible. Although some unofficial energy conservation and environmental protection indicators can greatly promote the evaluation accuracy of the algorithm [10], due to the failure to accurately grasp the attribute parameters of green building materials, the evaluation results will be distorted in the subsequent application of the algorithm, resulting in a certain type of green environmental protection and energy conservation indicators that cannot be included by the algorithm [7]. Then, it affects

the accuracy of environmental protection attribute description of building materials. In order to avoid the above situation, it is set to represent the average value of all green environmental protection and energy-saving indicators, and the specific screening results can be expressed as follows:

$$F = \frac{\sqrt{\bar{n} + (S_s + D_d)^2}}{G_g \times K - L_j}. \quad (5)$$

In (5),  $F$  represents the screening results of green environmental protection and energy conservation indicators,  $S_s$  represents the environmental protection and energy conservation attribute parameters of green building materials,  $D_d$  represents the composite structure factor of the algorithm,  $G_g$  represents the official parameters of energy conservation and environmental protection indicators,  $K$  represents the characteristic indicators of the evaluation function of the algorithm, and  $L_j$  represents the stable constant quantity of the ecological energy conservation index system of green buildings.

### 3. Analysis of Evaluation Algorithm Based on System Standard

The effect evaluation algorithm is used to judge the degree to which something plays a role. At present, the evaluation of green building materials focuses on economic and environmental benefits without considering other attributes, resulting in one-sidedness in the results of the evaluation algorithm. Therefore, this study will focus on not only the environmental attributes of building materials, but also the

resource attributes and energy attributes of building materials [11], so as to build a comprehensive environmental performance evaluation algorithm. Based on the establishment of green building ecological energy-saving index system and standard, the smooth application of the new green building ecological energy-saving effect evaluation algorithm is realized through the steps of calculating index weight and fuzzy synthesis operator.

**3.1. Weight Calculation of the Green Building Ecological Energy-Saving Index.** In the process of building the new green building ecological energy-saving effect evaluation algorithm, the green building ecological energy-saving index weight is an important index to determine the evaluation strength of the algorithm. Most index evaluation and decision-making processes must be applied to the index weight. Building ecological energy-saving index weight is the importance measurement unit between the index itself and the subject to be evaluated. Determining the index weight is of great significance to the evaluation of green building ecological energy-saving level, and it is an important link in the whole comprehensive evaluation process. The impact of each lower level indicator on the upper level indicator is different. Therefore, in order to objectively evaluate the environmental protection performance of green buildings, it is necessary to give each evaluation index a corresponding weight value. The greater the impact of the evaluation index on the model, the greater the weight value. In fact, general evaluation problems can be transformed into weight value calculation problems. Since the ecological energy-saving effect evaluation of green buildings involves many evaluation indexes, in order to reduce the amount of calculation, the most widely used analytic hierarchy process is used to determine the weight coefficient value of each index [12].

Analytic hierarchy process, referred to as AHP for short, is applied to the index weight calculation of the evaluation algorithm in this study. It refers to the method of decomposing each evaluation index related to the comprehensive environmental protection performance evaluation layer by layer, and then performing qualitative and quantitative analysis on each evaluation index on this basis. Its basic operation process is shown in Figure 2.

As shown in Figure 2, different index weight values will lead to different evaluation results [13]. For green buildings, the weighting of indicators reflects a kind of randomness to a great extent. Due to different environmental protection concepts adhered to by different construction units, the importance given to the same type of buildings is different. Therefore, under the concept of environmental protection and energy conservation, calculating the index weight of green building materials based on gray correlation degree is the primary link in the construction of new evaluation algorithm. The weight of building ecological energy conservation index can be expressed as

$$I = \frac{H_h - (X_g \times K_i - M_u)}{F} \times \theta. \quad (6)$$

In (6),  $H_h$  represents the measurement coefficient of the index,  $X_j$  represents the evaluation effect produced by the algorithm,  $K_i$  represents the environmental protection concept factor, and  $M_u$  represents the decision-making processing limit value of energy-saving index.

**3.2. Determination of the Fuzzy Evaluation Synthesis Operator.** The fuzzy evaluation synthesis operator of green building ecological energy-saving index can reflect the index weight and enhance the comprehensive evaluation degree of the evaluation algorithm. Without considering the influence of other external conditions, a single environmental protection and energy-saving index is not enough to judge the evaluation results of the algorithm, and when the upper limit of green building resources is limited, the energy-saving level of building materials cannot be clearly described by the algorithm. The fuzzy evaluation synthesis operator calculates the average binding coefficient of all indicators by using the weight of building ecological energy-saving indicators and then obtains the accurate operator synthesis result by combining a number of environmental protection and energy-saving level parameters. The upper limit value of green building material resources and the lower limit value of green building material resources are set. Let  $\alpha$  represent the upper limit value of green building material resources and  $\beta$  represent the lower limit value of green building material resources. Using  $\alpha$  and  $\beta$ , the energy consumption factor of the index can be expressed as

$$H_n = \alpha \times \beta \left( \left( \frac{Q_q}{P_p} \right)^2 + a \times b \right). \quad (7)$$

In (7),  $P_p$  represents the energy-saving level factor of green building materials,  $Q_q$  represents the comprehensive evaluation degree of the algorithm,  $a$  represents the judgment coefficient of the evaluation result of the algorithm, and  $b$  represents the comprehensive judgment coefficient. Let  $\bar{T}$  represent the average value of environmental protection and energy conservation level parameters; simultaneous formula (7) can express the fuzzy evaluation synthesis operator of green building ecological energy conservation index algorithm as

$$E = \frac{H_n}{\sqrt{Z_y} \times Z_e} \times m_1 \times n_1 \times \bar{T}. \quad (8)$$

In (8),  $m_1$  represents the target fuzzy evaluation parameter,  $n_1$  represents the original fuzzy evaluation parameter,  $Z_y$  represents the average evaluation synthesis time, and  $Z_e$  represents the periodic frequency of operator synthesis.

**3.3. Implementation of Evaluation Algorithm Process.** The evaluation process of green building ecological energy-saving effect evaluation algorithm takes the determination of comprehensive environmental factors as the starting link. Based on the gray correlation degree, the overall evaluation level of the algorithm can reach the expected standard

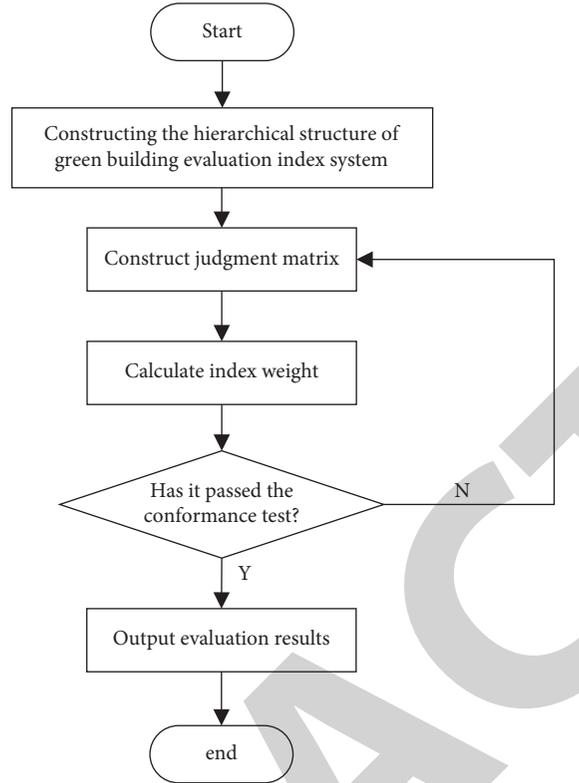


FIGURE 2: Operation process of analytic hierarchy process.

through the simultaneous establishment of environmental protection and energy-saving factors many times. Under the condition of ensuring the stability of the construction environment, there will be no obvious difference between the actual consumption and the target consumption of green building materials, but the related environmental protection and energy-saving indicators will fluctuate significantly with the increase of construction time. In order to avoid the influence of unstable indexes on the evaluation results of the algorithm, the actual consumption of green building materials is used as the evaluation basis, the actual consumption of materials is used as the main evaluation criterion, and the construction time is used as the operation cycle of the algorithm. On the premise that the framework of green building ecological energy-saving index system is stable, the grade of green building materials is divided by using environmental protection evaluation standards, and the accurate grade division results are used as the target operator to screen the environmental protection and energy-saving indexes that meet the evaluation standards. Based on the above operations, the index weight and fuzzy synthesis operator are calculated, and the above calculation results are used as the evaluation criteria of the algorithm to complete the evaluation and analysis of the ecological energy-saving index of green buildings. The detailed algorithm evaluation process is shown in Figure 3.

Under the influence of subjective factors, everyone's evaluation of something cannot be exactly the same. Therefore, in order to evaluate the performance of ecological energy conservation of green buildings, it is assumed that the

$i$  evaluation index makes the possible degree of the  $j$  evaluation scale. This possible degree is called subordination degree and recorded as  $Z_{ij}$ . Membership reflects the degree to which an object has a certain fuzzy property or belongs to a certain fuzzy concept. There are three evaluation scale subsets in the established comment set, and the membership vector obtained by each subset is

$$Z_i = (z_1, z_2, z_3), \quad i = 1, 2, 3. \quad (9)$$

Therefore, the established membership matrix is

$$Z = \begin{bmatrix} z_1 \\ z_2 \\ z_3 \end{bmatrix} = \begin{bmatrix} z_{11} & z_{12} & z_{13} \\ z_{21} & z_{22} & z_{23} \\ z_{31} & z_{32} & z_{33} \end{bmatrix}. \quad (10)$$

This membership matrix is a fuzzy relationship between the evaluation index and the comment set. Based on the known index weight  $C_n$  and membership matrix  $Z$ , the comprehensive evaluation vector of ecological energy-saving effect of green buildings is obtained as follows:

$$O = C_n \times Z = (C_{n1}, C_{n2}, \dots, C_{ni}) \begin{bmatrix} z_{11} & z_{12} & z_{13} \\ z_{21} & z_{22} & z_{23} \\ z_{31} & z_{32} & z_{33} \end{bmatrix} = (o_1, o_2, \dots, o_i). \quad (11)$$

In (11),  $o_1, o_2, \dots, o_i$  represent the comprehensive evaluation vector of each index.

To sum up, the comprehensive evaluation results of the algorithm are as follows:

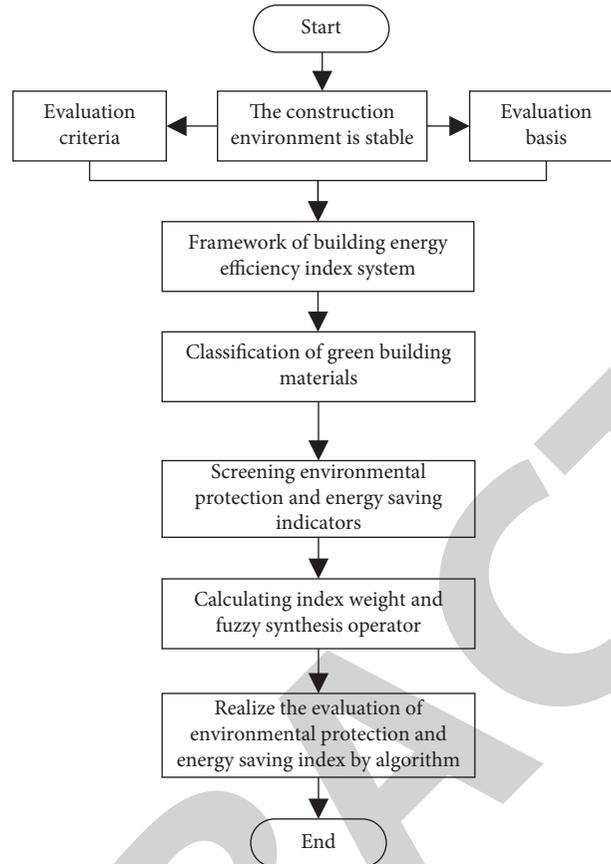


FIGURE 3: Flow chart of algorithm evaluation.

$$S = O \times P = (f_1, f_2, \dots, f_3, f_i) \begin{pmatrix} p_1 \\ p_2 \\ p_3 \end{pmatrix}. \quad (12)$$

According to the above process, the research on the evaluation algorithm of ecological energy-saving effect of green buildings based on gray correlation degree is completed.

#### 4. Experimental Analysis

In order to evaluate the effect and feasibility of the green building ecological energy-saving effect evaluation algorithm based on gray correlation degree, a simulation experiment is set up. In the experiment, a wood structure building covering an area of 185 m<sup>2</sup> is selected, its simulation structure is constructed on the Simulink platform, and the structure is used to test the ecological energy-saving effect of the green building under the proposed algorithm. The internal effect of wood structure is shown in Figure 4.

The evaluation results of ecological energy conservation are not fixed and low, have great fuzziness, and are easily affected by human factors. Therefore, they are usually described by a degree word rather than specific values, such as "good," "bad," "average," "poor," or "very poor." Therefore, this model can also be used to evaluate the ecological energy-saving effect of green buildings, using fuzzy set theory and

digital quantification to determine its energy-saving effect. Therefore, the comments on the energy-saving effect can be expressed through the following set:

$$J = \{j_1, j_2, j_3\}. \quad (13)$$

In (13),  $J$ ,  $j_1$ ,  $j_2$ , and  $j_3$  represent the comment set, "excellent," "medium," and "inferior," respectively. Generally, the numerical interval is used to determine the grade. For example, when its weight  $C_n$  is 1, the comment set for the comprehensive evaluation of ecological energy-saving effect of green buildings can be established as follows: excellent ( $C_n \geq 0.90$ ), medium ( $0.60 \leq C_n \leq 0.90$ ), inferior ( $C_n \leq 0.60$ ). Therefore, the weight value can be obtained according to each index, and the ecological energy-saving effect of green buildings based on gray correlation degree can be accurately positioned according to the above evaluation criteria.

The energy consumption factor  $H_n$  is set, and the energy consumption factor  $H_n$  is taken in the interval  $[0, 1]$ . The higher the value of energy consumption factor  $H_n$ , the worse the energy-saving performance of external maintenance structure of green building; On the contrary, the smaller the value of energy consumption factor  $H_n$ , the better the energy-saving performance of maintenance structure outside the building. The algorithm in this paper, the algorithm in [6], and the algorithm in [7] are used for testing, and the energy-saving performance of the three different algorithms is compared. The test results are shown in Figure 5.



FIGURE 4: Internal structure of wooden building.

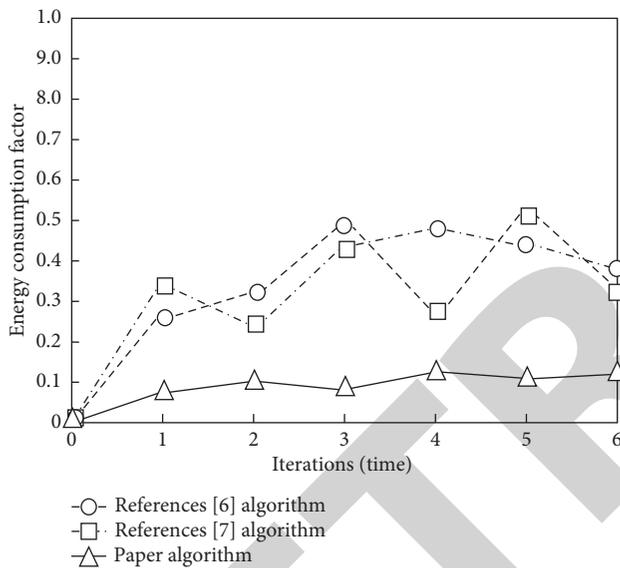


FIGURE 5: Comparison of energy consumption factors of three different methods.

It can be seen from Figure 5 that the energy consumption factors obtained by this method in multiple iterations are less than those of the algorithm in [6] and the algorithm in [7]. Because the algorithm calculates the weight of the ecological energy-saving index of green buildings and determines the comprehensive fuzzy evaluation operator, it is helpful to stabilize the influence of the external maintenance structure of the green building to a certain extent. According to the analysis results, the algorithm constructs an energy-saving optimization design target algorithm, reduces the energy consumption of the external maintenance structure of the green building, and verifies that the algorithm has good energy-saving performance.

The experimental index is set as the fitting degree between the simulated structure and the actual energy-saving

results. The evaluation results before and after the application of this algorithm are shown in Figure 6.

By analyzing the experimental results in Figure 6, it can be clearly seen that in terms of the degree of fitting with the actual energy saving, the fitting degree curve of the actual energy-saving effect fluctuates continuously before the application of the designed algorithm, while the energy-saving effect after the application of the green building ecological energy-saving effect evaluation algorithm based on gray correlation degree is better than that before the application, and the fitting degree curve has good stability and long-term fitting.

After determining that the fitting degree meets the requirements of energy-saving effect, the following two evaluation indexes are established to determine the advantages and disadvantages of the proposed algorithm: the maximum energy-saving effect and the maximum cost increment. At the same time, the design effects of the algorithms in [6] and [7] are compared, and the comparison results are shown in Figures 7 and 8:

- (i) Maximum energy-saving effect: the calculation formula for the maximum energy-saving effect that the design algorithm can achieve is as follows:

$$W_{\max} = \frac{(R_{\max} - R_r)}{R_r}. \quad (14)$$

- (ii) Maximum cost increment: the economic benefits shown by the transformation design algorithm are described by the following formula:

$$K_{\max} = \frac{(B_{\max} - B_r)}{B_r}. \quad (15)$$

In (15),  $W_{\max}$  and  $K_{\max}$ , respectively, represent the maximum energy-saving rate and cost increment;  $R_{\max}$  represents the maximum annual energy consumption;  $R_r$  represents the average annual energy consumption of the target building;  $B_{\max}$  represents the highest construction cost in the design algorithm; and  $B_r$  represents the reconstruction cost of the building.

As can be seen from Figures 7 and 8, the maximum energy-saving effect is most obvious in winter and summer. The proposed design algorithm can save more power. Through the transformation and design of the roof, ground, and windows of green buildings, it can make the indoor warm in winter and cool in summer, reduce the use time of air conditioning in winter and summer, and achieve the purpose of energy conservation and environmental protection. In addition, the cost increment of the algorithm is also the lowest, because this algorithm simulates and constructs the overall structure of the green building and carries out similarity analysis, so as to transform the design on the basis of ensuring the maximum similarity of the original building and reduce the cost consumption.

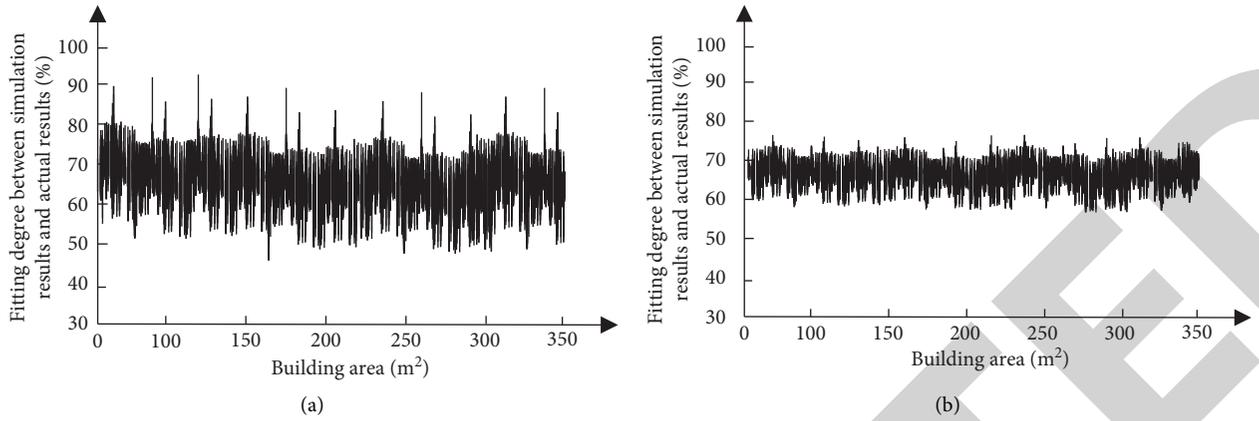


FIGURE 6: Comparison of fitting degree between different designs and actual energy saving before (a) and after (b) applying the algorithm in this paper.

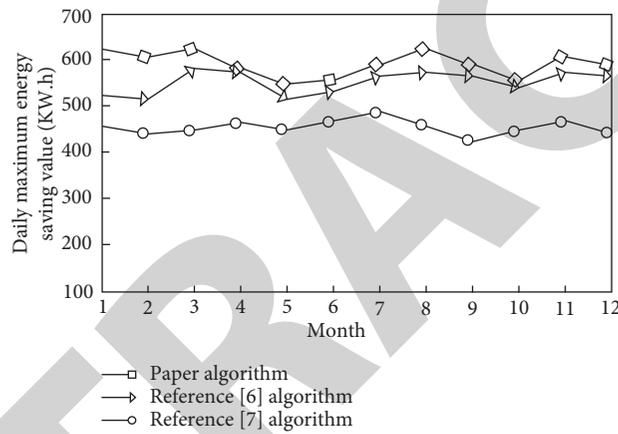


FIGURE 7: Comparison results of the maximum energy-saving effects of different algorithms.

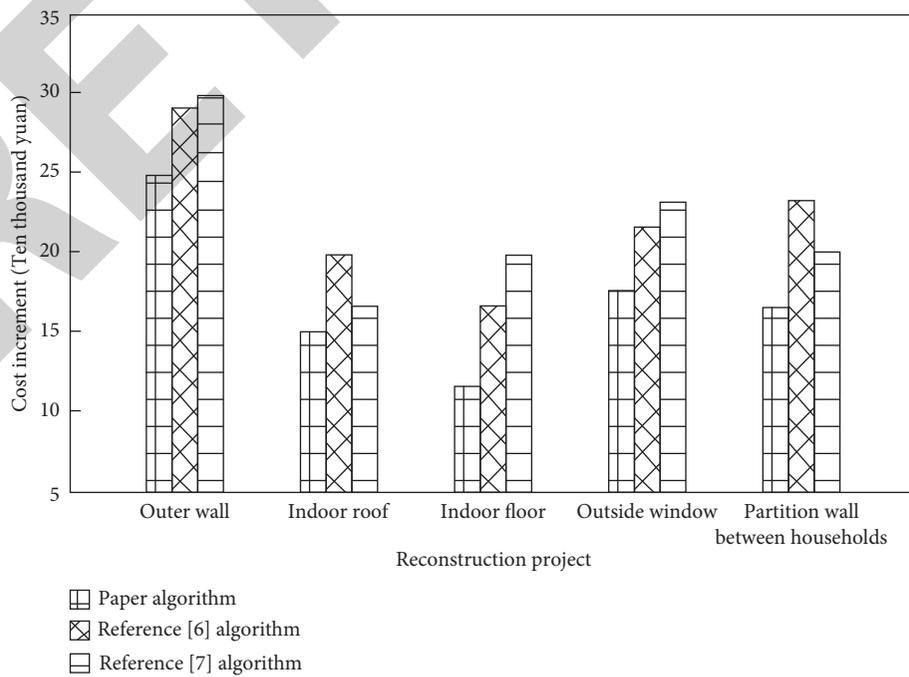


FIGURE 8: Comparison results of the cost increment of different algorithms.

## 5. Conclusion

Green building ecological energy conservation is a complex system integrating planning, design, and other disciplines, which can only be completed under a large amount of theoretical knowledge and practice. The evaluation algorithm of green building ecological energy-saving effect based on gray correlation degree comprehensively considers the constraints of multiobjective factors, establishes the index system and standard of green building ecological energy saving, analyzes the evaluation algorithm based on the system standard, and obtains the optimal result. It is proved that the energy consumption factor of the algorithm is low, the energy-saving effect of the designed algorithm is better than that before application, and the fitting degree curve has good stability and long-time fitting. It can not only save energy, but also reduce the transformation cost. Although the algorithm in this paper has strong universality, it does not consider the specific application. Green building will be widely used in the future, so the algorithm still has room for improvement. More relevant modules should be added to further improve the universality of the algorithm.

## Data Availability

The data used to support the findings of this study are available from the author upon request.

## Conflicts of Interest

The author declares that he has no conflicts of interest.

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