Acta Technica *62* (2017), No. 7A, 55–68

Study on Influencing Factors and Prediction Model of Urban Residential Building Energy Consumption

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Abstract. The rural building energy-saving evaluation method is proposed by using grey Euclid-TOPSIS level model of game and compromise weight to build and improve the energy-saving evaluation level of new rural building and better guide the energy-saving construction of rural building. In this paper, the rural public building is used as research object to establish the theoretical index evaluation method for the rural public green buildings and make weight combination assignment based on game and compromise weight model, making it more reasonable. Then, the grey Euclid program is used to take into full consideration of model relevance. Finally, the TOPSIS criteria sequence is used to achieve ranking for green index of rural public building and the real cases are used to evaluate the energy saving program and verify practicability of rural public building evaluation model. The instance analysis shows that the overall image construction requirements of the new rural areas are related to the traditional customs, satisfaction of transformation, integration of residents' living habits, electricity saving, diversification of rural investment and other attributive characters.

Key words. Building energy saving, TOPSIS decision, Energy consumption prediction, Building image design, Analytic Hierarchy Process.

1. Introduction

At present, the most of rural houses in China always ignore the energy-saving level in the construction process, resulting in less heat preservation facilities equipped in houses, and failing to consider the waste recycling, which do not meet the current requirements of green building [1]. With the state's attention to the concept of green building, the relevant policies have been introduced, now the energy saving and improvement work for existed houses and building in rural areas are also ongoing [2].

The theoretical research of green building has become the research focus of re-

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searchers at home and abroad, and China is also exploring the construction of green building system in line with China's actual conditions according to the national condition[3, 4]. In literature [5], the SABA evaluation theoretical framework of green building conforming to the country's actual conditions is established according to the effect characteristics and different functions of economy, environment and society on green building; in literature [6], for the functional characteristics of public hospital, the evaluation criteria research work for green building in special field is carried out; in literature [7], the comparative analysis on the current commonly used LEED, BREEAM, GBTool and other theoretical frameworks of green building is conducted, putting forward the theoretical framework of green building conforming to its study background; in literature [8], the new theoretical framework of green building is constructed for four dimensions of output, input, effect and process; in literature [9], the comprehensive extension evaluation scheme is used for building energy-saving evaluation in theoretical framework of green building. There are many such literatures, so no more details. At present in the study of the theoretical framework of green building, many scholars analyzed from the aspects of qualitative but less from quantitative, especially there are less research achievements on correlation between evaluation level and index, and the distinction between residential and public building is ignored to be considered in the framework research of green building.

2. Establishment of evaluation index system

2.1. Description on evaluation system

There are many factors affecting the energy-saving efficiency of rural public buildings, and the construction of a systematic evaluation index is the prerequisite to optimize the energy-saving schemes of rural public buildings. Here according to the scientific principle, comprehensive and level principle, the effecting reasons of green energy-saving scheme are comprehensively analyzed combining with the actual situation, to construct the optimized frame of the evaluation index of energy-saving scheme for rural public building, as shown in Figure 1.

Among which, there are fuzzy and uncertain characteristics for determination of the relevant qualitative indexes, for example, the definition of rural investment diversification index A21 is fuzzy in evaluation index of energy saving system for rural public green building as shown in Figure 1, which is not easy to conduct automatic calculation of evaluation value, the alternative scheme here is taken to be obtained by inviting experts and scholars to score through questionnaire, the scoring range is 0 to 100, and normalized, in addition, there are similar problems in unity of rural planning A44, new rural construction of overall image A24 and other indexes

Since here is the evaluation and decision of energy saving for rural building, the unity of rural planning A44, new rural construction of overall image A24, rural investment diversification index A2, rural reconstruction planning and landscape A43 and other evaluation indexes with rural characteristics, which is different from other types of building.

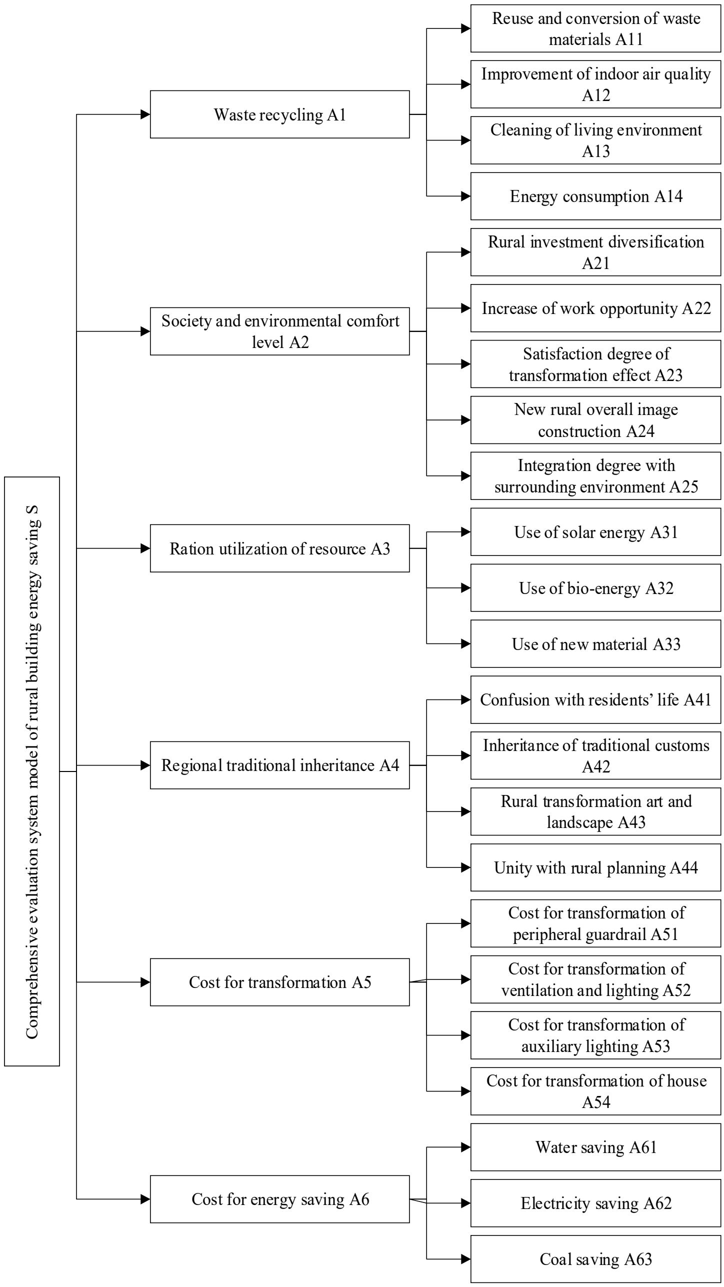


Fig. 1. Evaluation index of rural public green building

2.2. Construction of relationship matrix based on fuzzy evaluation

Based on the scoring method of fuzzy interval, the fuzzy concept of green building is disposed[10], and using the selected membership function to map the evaluation index elements to the domain of discourse, to produce comparable elements existing between different indexes. The classical membership functions include normal, ridge type, trapezoid and so on, which adopt equal length method for interval classification, so the membership function with common form is generally used. In the interval grading process, the psychological measure theory is used to change the different interval scales. At the same time, when constructing different types of membership functions, which are subject to the most clear and most fuzzy principles, namely center of interval to meet the most fuzzy feature, the general setting membership is 0.5; and the two end position to meet the most clear feature, the general setting membership is 1; the boundary position of interval also has the most clear feature, the general setting membership also is 1; all points meet the condition of membership is the sum of 1. The actual measured values and their corresponding membership relationships are shown in Figure 2.

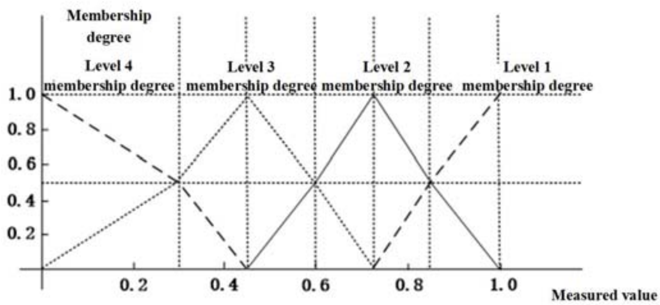


Fig. 2. Membership function curve

If taking one point in the taking value interval of measured values as shown in Figure 2 at random, the total of membership degree for corresponding Level 1∼4 is 1. According to the measured value of the evaluation index, the membership degree $(R\,|u_i\,)$ of single index belonging to fuzzy level is calculated, and the relationship matrix of fuzzy evaluation is obtained as follow:

$$D = \begin{bmatrix} D\,|u_1 \\ D\,|u_2 \\ \cdots \\ D\,|u_p \end{bmatrix} = \begin{bmatrix} d_{11} & d_{12} & \cdots & d_{1m} \\ d_{21} & d_{22} & \cdots & d_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ d_{p1} & d_{p2} & \cdots & d_{pm} \end{bmatrix}. \tag{1}$$

In the matrix D shown in Formula (1), the first index d_{ij} of i row indicates the level membership degree of index v_j from the factor u_i.

3. Game compromise weight

3.1. Weight determination

Firstly, the weight ω_1 of the subjective evaluation indexes are determined based on the AHP method, and the weight ω_2 of the objective evaluation indexes are determined by the entropy method, finally, the weight ω of the comprehensive evaluation indexes are constructed by the game compromise model. The calculation process of AHP weight is [11]: ① construction of judgment matrix, ② one-time single sort verification, ③ one-time total sorting hierarchical verification. The entropy can present the degree of disorder expressed by information, entropy value is smaller, which indicates that the amount of information can be provided is greater, the function in the evaluation process of green building is more obvious, the index weight is larger, indicating its importance is big. The concrete process is as follow:

Step1: The relationship matrix $D = (d_{ij})_{m\times n}$ of above obtained fuzzy evaluation can be normalized to obtain $R = (r_{ij})_{m\times n}$. If d_{ij} is an evaluation index that pays more attention to benefits, the $r_{ij} = (d_{ij} - \min d_j)/(\max d_j - \min d_j)$ can be obtained. If d_{ij} is an evaluation index that emphasizes the cost, the $r_{ij} = (\max d_j - d_{ij})/(\max d_j - \min d_j)$ can be obtained. In the formula, d_{ij} is the index j of the plan i, $i = 1, 2, \cdots, m$, $j = 1, 2, \cdots, n$. The n indicates the total number of evaluation indexes, and m represents the total number of evaluation schemes.

Step2: Calculate the proportion index p_{ij}, $p_{ij} = r_{ij} \Big/ \sum\limits_{i=1}^{m} r_{ij}$, then the entropy value of this index is $E_j = \sum\limits_{i=1}^{m} p_{ij} \cdot I \cdot n \cdot p_{ij} \Big/ I \cdot n \cdot m$, if $p_{ij} = 0$, $p_{ij} \cdot I \cdot n \cdot p_{ij} = 0$, and then $0 \le E_j \le 1$ can be obtained.

Step3: According to the relevant definition of entropy value, the weight of index j can be calculated as $w_j = (1 - E_j)/ \sum\limits_{j=1}^{n} (1 - E_j)$, the weight form of objective index is $\omega_2 = (w_1, w_2, \cdots, w_n)$.

3.2. Game compromise model

The research in literature [8] shows that the game compromise model can realize the minimum deviation between the weights, to improve the reasonability of weight setting, here calculate the compromise game model on the base of the above weights, the following calculation steps can be obtained:

Step1: if there are L kinds of strategies to determine the index weight, the set vector of weight is $\omega(k) = (\omega_{k1}, \omega_{k2}, \cdots, \omega_{kn})$, and $k = 1, 2, \cdots, L$. The combination form of vector weight of L groups is $\omega = \sum\limits_{k=1}^{L} \alpha_k \omega_k^T$, where, ω means the possible vector set of index weight, α_k means the one-dimensional coefficient to carrying out linear combination practice.

Step2: Select two goals, that is ω and ω_k, taking coefficient α_k with minimum deviation as the coefficient of above linear combination:

$$\min|\sum_{j=1}^{L}\alpha_j\omega_j^T-\omega_j^T|, i=1,2,\cdots,L. \tag{2}$$

The above procedure is equivalent to solving the optimal derivative of linear equations:

$$\sum_{j=1}^{L}\alpha_j\omega_i\omega_j^T=\omega_i\omega_i^T, i=1,2,\cdots,L. \tag{3}$$

After solving the equation set, the linear coefficient can be obtained as $(\alpha_1,\alpha_2,\cdots,\alpha_L)$, and $\alpha^*=\alpha_k/\sum_{k=1}^{L}\alpha_k$ can be obtained through normalization practice, the above comprehensive weight is as follow:

$$\omega^*=\sum_{k=1}^{L}\alpha^*\omega_k^T, k=1,2,\cdots,L. \tag{4}$$

4. Grey Euclid evaluation model

5. Reference of constructing comparative sequence

The basic principle of grey Euclid is to analyze the degree of correlation between various factors in the grey system through the similarity between the geometrical shape of the sample sequence and the reference sequence curve, so that the model evaluation accuracy can be effectively improved. Firstly, construct a reference sequence $x_0=\{x_0(k)\,|k=1,2,\cdots,n\}$, then its corresponding comparative sequence is $x_i=\{x_i(k)|k=1,2,\cdots,n\}$, where, $i=1,2,\cdots,m$. The following calculation form can be obtained:

$$x_j=\frac{x_i(k)}{x_0(k)}(i=1,2,\cdots,m;k=1,2,\cdots,n). \tag{5}$$

In the Formula (5), the comparative sequence includes the indexes of energy saving of rural public buildings: transformation cost, energy saving cost, waste environmental protection utilization and other indexes can be obtained by normalization practice.

5.1. Calculation of grey weighting correlation degree

All the correlation coefficients in the reference and comparative sequences are calculated to obtain the following form:

$$\xi_{0i}(k)=\frac{\min\limits_i\min\limits_k|x_0(k)-x_i(k)|+\rho\max\limits_i\max\limits_k|x_0(k)-x_i(k)|}{|x_0(k)-x_i(k)|+\rho\max\limits_i\max\limits_k|x_0(k)-x_i(k)|}. \tag{6}$$

In the Formula (6), because the whole correlation degree has great influence on the value taking of ρ, and determines the error in the correlation space, it should dynamically calculate and update the resolution coefficient ρ according to the evaluation condition of index:

$$\bar{\Delta} = \frac{1}{nm} \sum_{i=1}^{m} \sum_{k=1}^{n} |x_0(k) - x_i(k)| . \tag{7}$$

Suppose that $\mu_\Delta = \bar{\Delta}/\Delta_{\max}$, and $\Delta_{\max}$ is the maximum value of $|x_0(k) - x_i(k)|$, then the value taking range of P is $\mu_\Delta \leq \rho \leq 2\mu_\Delta$, and when meeting the condition of $\Delta_{\max} > 3\bar{\Delta}$, $\mu_\Delta \leq \rho \leq 1.5\mu_\Delta$ can be obtained; if meeting the condition of $\Delta_{\max} \leq 3\bar{\Delta}$, $1.5\mu_\Delta < \rho \leq 2\mu_\Delta$ can be obtained.

Then the evaluation weighted degree r_{0i} of weighting grey correlation degree can be calculated:

$$r_{0i} = \sum_{i=1}^{n} [\omega_i(k) \cdot \xi_{0i}(k)] . \tag{8}$$

In the Formula (8), the comprehensive corresponding weight of coefficient $\xi_{0i}(k)$ is $\omega_i(k)$.

5.2. Calculation of weightingcorrelation degree

Considering the fluctuation of the weighted mean r_{0i} relative to the reference and the comparative coefficients and its influence on the calculation of correlation degree, the weighted grey correlation correction is realized by combining the Euclid strategy, and the correlation degree is obtained as follow:

$$\bar{r}_{0i} = 1 - [(r_{0i} - 1)^2 + \sum_{k=1}^{n} \omega_j(k) \left(\xi_{0i}(k) - r_{0i}\right)^2]^{1/2} . \tag{9}$$

Based on Euclid weighted relative correlation degree, the evaluators is sorted according to the correlation degree, the larger the value is, the impact of which on evaluation results is greater, the next section will use TOPSIS criteria fusion method to obtain Clid weighted correlation degree for decision.

6. TOPSIS criteria fusion decision

6.1. Algorithm flow of multiple criteria

At present, there are many criteria decision fusion strategy [12, 13], and the decision algorithm flow is shown in Figure 3.

As shown in Figure 3, $C = \{C_1, C_2, \cdots, C_m\}$ is the criterion of m-dimension, $W_C = \{W_{C_1}, W_{C_2}, \cdots, W_{C_m}\}$ is the corresponding weight of the above criterion, it is mainly to distinguish the importance of the criterion. The fuzzy TOPSIS decision process used in the figure includes: (1) extracting the information characteristics of

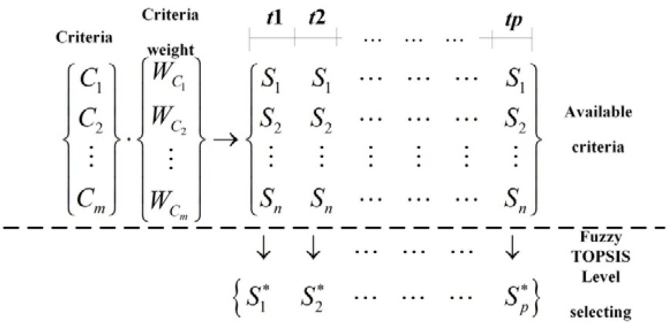


Fig. 3. Decision process

criterion; (2) extracting the weight information; (3) determining the fuzzy grade of TOPSIS.

6.2. Step of decision algorithm

In the decision-making process of classical criteria, the weight value W_C of criteria decision includes: unknown information, incomplete information, uncertain information and so on, these information weights cannot be quantified by traditional methods. Therefore, the criteria decision algorithm based on fuzzy theory is proposed:

Step 1: Construction of decision incidence matrix. If containing evaluation indexes $S_i\,(i = 1, 2, \cdots, m)$ of m groups, the corresponding criteria is $C_j\,(j = 1, 2, \cdots, n)$, then the decision matrix can be formed as follows:

$$X = \begin{array}{c} \\ S_1 \\ S_2 \\ \vdots \\ S_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array} . \tag{10}$$

In the Formula (10), x_{ij} is the quantitative value of the judging index S_i with respect to the judging criteria C_j.

Step2: Weight entropy assignment of judging index. In order to realize the measured value of weight entropy objectively, it is necessary to normalize the matrix relative to the criteria $C_j\,(j = 1, 2, \cdots, n)$, and to obtain the criteria projection P_{ij}:

$$P_{ij} = x_{ij} \Big/ \sum\nolimits_{i=1}^{m} x_{ij} \,. \tag{11}$$

The acquired entropy value is:

$$e_j = -\left(\ln m\right)^{-1} \cdot \sum_{j=1}^{n} p_{ij} \ln p_{ij} \,. \tag{12}$$

The corresponding weight of criteria is:

$$W_{C_j} = (1 - e_j) \Big/ \sum\nolimits_{k=1}^{n} (1 - e_k)\,. \tag{13}$$

Step3: The fuzzy TOPSIS decision matrix is constructed as follow:

$$\tilde{R} = [\tilde{r}_{ij}]_{m \times n}\,. \tag{14}$$

The fuzzy values (a_{ij}, b_{ij}, c_{ij}) are constructed by fuzzy rules shown in Figure 2 to obtain the follow:

$$\begin{cases} \tilde{r}_{ij} = \left(\dfrac{a_{ij}}{c_j^+}, \dfrac{b_{ij}}{c_j^+}, \dfrac{c_{ij}}{c_j^+} \right), & if\ j \in F \\ \tilde{r}_{ij} = \left(\dfrac{a_j^-}{c_{ij}}, \dfrac{a_j^-}{b_{ij}}, \dfrac{a_j^-}{a_{ij}}, \right), & if\ j \in C \end{cases} \tag{15}$$

In the Formula (15):

$$\begin{cases} c_j^+ = \max c_{ij}\,, & if\ j \in F \\ a_j^- = \min a_{ij}, & if\ j \in C \end{cases} \tag{16}$$

Step4: According to the criteria weight calculated by Step 2 and combining the fuzzy matrix solved by Step 3, the following evaluation weighting matrix can be obtained:

$$\tilde{V} = \begin{bmatrix} \tilde{v}_{11} & \tilde{v}_{12} & \cdots & \tilde{v}_{1n} \\ \tilde{v}_{21} & \tilde{v}_{22} & \cdots & \tilde{v}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{v}_{n1} & \tilde{v}_{n2} & \cdots & \tilde{v}_{nn} \end{bmatrix} = \begin{bmatrix} \tilde{r}_{11} & \tilde{r}_{12} & \cdots & \tilde{r}_{1n} \\ \tilde{r}_{21} & \tilde{r}_{22} & \cdots & \tilde{r}_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{r}_{m1} & \tilde{r}_{m2} & \cdots & \tilde{r}_{mn} \end{bmatrix} \cdot diag \left\{ W_{C_1}, \cdots W_{C_n} \right\}\,. \tag{17}$$

Step5: The weighting criterion obtained in Formula (16) can be used to evaluate the ordering of matrix, and the positive and negative ideal solutions A^+ and A^- can be obtained:

$$\begin{cases} A^+ = \left(\tilde{v}_1^+, \tilde{v}_2^+, \cdots, \tilde{v}_n^+ \right)\,, \\ A^- = \left(\tilde{v}_1^-, \tilde{v}_2^-, \cdots, \tilde{v}_n^- \right)\,. \end{cases} \tag{18}$$

Step6: Solving the distance between positive and negative ideal solutions:

$$d\,(A_1, A_2) = \sqrt{\frac{1}{3} \left[(a_1 - a_2)^2 + (b_1 - b_2)^2 + (c_1 - c_2)^2 \right]}\,.$$

$$\begin{cases} d_i^+ = \sum\limits_{j=1}^{k} d\left(\tilde{v}_{ij}, \tilde{v}_j^+\right), i = 1, 2, \cdots m\,, \\ d_i^- = \sum\limits_{j=1}^{k} d\left(\tilde{v}_{ij}, \tilde{v}_j^-\right), i = 1, 2, \cdots m\,. \end{cases} \tag{19}$$

According to the above steps, the factor sorting of key indexes for energy saving star level of rural buildings can be obtained.

7. Example application

7.1. Experimental subject

The total area of rural public building is 18,000 m2, the materials used in construction project is from local sources combining with ecological and energy saving and emission reduction design, the energy saving rate of construction project is more than 50%, recycling rate of re-grown material is 10.7%. The construction project was awarded the evaluation mark of three stars level green building.

Table 1. Fuzzy judgment matrix S-A

S	A_1	A_2	A_3	A_4	A_5	A_6
A_1	$[1,1]$	$[1/2,1]$	$[1,2]$	$[1/3,1/2]$	$[1/4,1/2]$	$[1/4,1/2]$
A_2	$[1,2]$	$[1,1]$	$[1/3,1/2]$	$[1,2]$	$[1/2,1]$	$[3,4]$
A_3	$[1/2,1]$	$[2,3]$	$[1,1]$	$[1/2,1]$	$[1,2]$	$[1/3,1]$
A_4	$[3,4]$	$[3,4]$	$[1/2,1]$	$[1,1]$	$[1/3,1/2]$	$[2,3]$
A_5	$[1/3,1]$	$[1/3,1/2]$	$[2,3]$	$[3,4]$	$[1,1]$	$[1/3,1]$
A_6	$[1/4,1/2]$	$[3,4]$	$[1,2]$	$[1/3,1/2]$	$[1/4,1/2]$	$[1,1]$

Table 2. Fuzzy judgment matrix A1

A_1	A_{11}	A_{12}	A_{13}	A_{14}
A_{11}	$[1,1]$	$[2,3]$	$[1/3,1/4]$	$[2,3]$
A_{12}	$[1/3,1/2]$	$[1,1]$	$[1,2]$ $[1/3,1/2]$	$[1,2]$
A_{13}	$[4,3]$	$[1/2,1]$	$[1,1]$	$[1,2]$
A_{14}	$[1/3,1/2]$	$[2,3]$	$[1/2,1]$	$[1,1]$

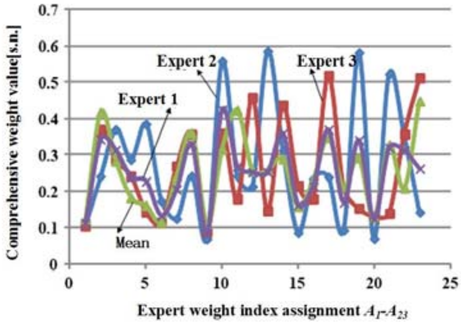
In the form of questionnaires, three experts from the domestic construction industry are specially invited to compare the importance of the evaluation indexes shown in Figure 1 in pairs, and the judgment matrix meeting interval sign is obtained, and then each weight index can be obtained. For reasons of space, here taking the evaluation results from Expert 1 as example, the judgment fuzzy matrix is shown in Table 1 and 2, and other judgment matrices $A_2 \sim A_5$ are constructed in a similar way, so no more detailed description.

According to the hierarchical interval method, the results from Expert 1 can be calculated to obtain the lower judgment weight: $W = [0.106, 0.280, 0.119, 0.084, 0.161, 0.250]$. The weighted average value of the 1 level evaluation index is assigned by the three specially invited experts as $W_1 = [0.104, 0.258, 0.133, 0.160, 0.147, 0.198]$, and the other weight value of 2 level indexes and the weight of comprehensive evaluation index can be seen in Table 3 to 4.

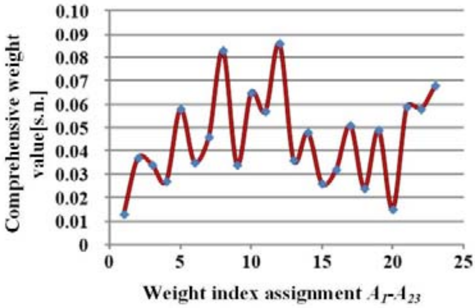
Table 3. The weight of the 2 level indicators

Index weight	Expert 1	Expert 2	Expert 3	Average value	Comprehensive weight
A_{11}	0.105	0.105	0.123	0.112	0.013
A_{12}	0.241	0.370	0.418	0.343	0.037
A_{13}	0.370	0.286	0.283	0.313	0.034
A_{14}	0.287	0.242	0.183	0.238	0.027
A_{21}	0.385	0.142	0.161	0.227	0.058
A_{22}	0.173	0.115	0.116	0.132	0.035
A_{23}	0.124	0.269	0.243	0.205	0.046
A_{24}	0.242	0.357	0.361	0.329	0.083
A_{25}	0.068	0.089	0.112	0.083	0.034
A_{31}	0.558	0.359	0.317	0.424	0.065
A_{32}	0.242	0.179	0.423	0.268	0.057
A_{33}	0.213	0.458	0.257	0.252	0.386
A_{41}	0.586	0.146	0.258	0.252	0.036
A_{42}	0.312	0.437	0.289	0.359	0.048
A_{43}	0.086	0.216	0.158	0.163	0.026
A_{44}	0.234	0.179	0.231	0.214	0.032
A_{51}	0.239	0.519	0.348	0.369	0.051
A_{52}	0.093	0.211	0.212	0.169	0.024
A_{53}	0.582	0.153	0.292	0.341	0.049
A_{54}	0.069	0.131	0.127	0.123	0.015
A_{61}	0.523	0.139	0328	0.319	0.059
A_{62}	0.352	0.357	0.209	0.312	0.058
A_{63}	0.142	0.512	0.448	0.262	0.068

Table 4A shows the assignment of weight evaluation for each index and the corresponding mean by different experts, it can be seen that the different experts are different for recognized degree of index, but has the generally same trend, namely, the above experts hold the roughly consistent opinion for the importance of recognized degree for same index, see Fig. 4a for specific details. Table 4b shows the calculated value of comprehensive weight of weight index based on the weight assignment evaluation by above experts, which reflects the different importance of different indexes on evaluation, which fully embodies the rationality of weight assignment calculation, as shown in Figure 4b.



(a) Expert weight assignment



(b) Comprehensive weight

Fig. 4. Schematic diagram of index weight

7.2. Euclid comprehensive evaluation

According to the Green Building Evaluation Technical Instructions promulgated by the state, the factor evaluation of green star level for the rural green building project is conducted combining with the indexes shown in Figure 1, and combining with Table 1 to 2 and other judgment fuzzy matrices to convert the values so as to solve. In the reference sequence, the corresponding index values of one star to three stars judgment level respectively are 1, 2 and 3. The initial data is processed in a dimensionless manner, and the parameter Δ_{ij} is calculated by combining Formula (5). $\Delta_{\min} = 0$ and $\Delta_{\max} = 1$ can be obtained, the correlation of each factor and resolution coefficient can be calculated according to the Formula (5 to 6), and then the weighted grey correlation degree $r_{0i} = (0.679, 0.786, 0.672)$ can be calculated as per the comprehensive weight of Table 3. According to Formula (9), the correlation degree of relatively grey Euclid can be weighted in the form of $r'_{0i} = (0.612, 0.733, 0.624)$.

7.3. Results analysis

According to the research results of grey Euclid, the maximum r'_{0i} level is the star level of rural green building project to be evaluated, $r'_{03} > r'_{02} > r'_{01}$ and $r_{\max} = r'_{03}$ can be known according to the calculated results of r'_{0i}, the project to be evaluated is three stars level green building, which is consistent with the real evaluation result. At the same time, according to Formula (10) , the following can be calculated: $c(j) =$ (0.012, 0.037, 0.031, 0.023, 0.116, 0.112, 0.163, 0.247, 0.081, 0.109, 0.068, 0.079, 0.132, 0.172, 0.024, 0.067, 0.113, 0.052, 0.049, 0.053, 0.066, 0.118, 0.068), sorting the above results, the following sequence can be obtained: $c(A_{24}) > c(A_{42}) > c(A_{23}) > c(A_{41}) > c(A_{62}) > c(A_{21})$. So the factors affecting the star level of rural green building project as per importance can be sorted as follow: the overall image of new rural construction, and the traditional custom of inheritance, satisfaction degree of transformation, and the integration with residents' living habits, electricity saving and rural investment diversification.

8. Conclusion

This paper presents a rural building energy saving evaluating method with game compromise weighted grey Euclid-TOPSIS hierarchical model. In view of its own characteristics of green public building and the standards to be achieved, the evaluation index system of public green building is constructed from the view of land saving, energy saving, water saving, materials saving, indoor environment and other 18 indexes, and the fuzzy relationship matrix of energy-saving evaluation for rural building by fuzzy method is established, and then using the comprehensive weights of evaluation indexes can be obtained by game compromise method, and to sort the importance of index for rural building energy saving based on TOPSIS decision mode. The structure of this system can be used to comprehensively evaluate the level of green public building, which has strong practicability and can find the influence factors for evaluating green building, and to establish the direction of improvement.

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Received May 7, 2017