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Evaluation System of Breen Building Property Management Based on AHP

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ABSTRACT: At present, China's housing construction has set off a "green tide", and the State Ministry of housing has issued some regulations and to encourage the construction of green residential districts. Green residential district is the development trend of the building industry in 21st Century. According to the actual problems of green building in the property management, the paper studies the property management of green building from the aspects of energy saving, environmental protection and other aspects so as to choose a reasonable and scientific property management mode aiming at the specific reality of China's green building. In the process of building a comprehensive evaluation index system of green building property management model in China, the author uses the AHP method proposed by American scholar T. Lassty. AHP is a structured technique for organizing and analyzing complex decisions combining qualitative and quantitative analysis method. It has simple using idea and wide practical value. On this basis, the author makes an improvement on the constructing method of its judgment matrix, making the matrix be more operable.

KEYWORDS: Green building; Property management; Evaluation; Analytic hierarchy process.

INTRODUCTION

China is currently in a period of rapid economic development, and with the continuous improvement of urbanization in the country, the construction and real estate industry is continuously developing. China's existing construction area is now more than 44 billion square meters with annual new construction area of about 2 billion square meters, which is about half of construction areas in the whole the world. The data show that the carbon emissions of buildings account for more than 30% of the entire social carbon emissions and carbon emissions during operation period after finishing the building process account for more than half of the entire carbon emissions of the building, such as building rubbish accounting for 40% of the total rubbish produced in human activities. This is undoubtedly a great challenge to our country's resources and environment.

RESEARCH BACKGROUND

With the construction of conservation oriented society and the continuous development of energy conservation of building, green building projects are constantly growing. At present, in real estate market, "green" concept has become a new selling point of various real estate development enterprises which frequently launch green residential and green office which is eco and environmental protective. And new concepts are emerging endlessly such as green decoration, green energy, green landscape, etc. Faced with more and more constructed "green" buildings, based on continuous rise of "green" building and the owner's demand for the green consumption, property management that advocates green building has become the inevitable trend of building development.

However, through the investigation of the green buildings which have been put into use, it is found that the quality of property management personnel is not high, and they are short of "green" awareness. Management personnel are not familiar with the new technology and equipment, and can not initiatively take scheduled statistic analysis of operating data. Besides there lacks of a comprehensive property management strategy, directly affecting the operation of the green building. With the continuous more and more green buildings being put into use, the problem of backward property management technology become more and more serious. Property management companies lack of researches on management technology and methods which suit for the green buildings, and they are still using the traditional property management technology which mainly focus on the equipment and facilities maintenance, green conservation etc and can not guarantee the smooth operation of the green building, not mention to meet the requirements of "four savings and one protection". Based on the above background, the analysis and research of the green building's property management should be carried out as soon as possible and are very urgent. The research

contents provide the feasible green building management scheme for the property management enterprise, and then provide technical reserve to improve the management level of the entire property management industry.

AHP is a structured technique for organizing and analyzing complex decisions combining qualitative and quantitative analysis method, which is used in a wide variety of fields such as engineering, business, military, politics and diplomatic and solves many important problems such as system evaluation, resource allocation, price forecasting, and project selection. Its basic principle is to put a complex evaluation system, according to its internal logic relations, into an orderly hierarchical structure with evaluation index as representatives; For the index of each level, compare every two of indexes in the same level based on expert's knowledge, information and values, and then use the mathematical method to calculate the weight of each index; Finally, the system analysis is reduced to a ranking problem which needs to determine the importance weights of the lowest level (such as decision scheme) relative to importance weights of the most senior level (overall objective). The basic steps are as follows: analyzing the problem and establishing hierarchical structure; constructing pair-wise judgment matrix to comparing the importance of each pair of indexes and making assignment; single level ranking and consistency checking; total level ranking and consistency checking; the synthesis of group judgment matrix.

CONSTRUCTING EVALUATION INDEX SYSTEM

Goal Level (A)

Index A is the evaluation effect of evaluated property management.

Criteria Level (B)

B_1 is index of land saving and green facilities, B_2 is index of water saving, energy saving and energy utilization, B_3 is index of environment making and environment protection, B_4 is index of indoor environmental quality, B_5 is index of long-term environmental protection value, and B6 is index of the spiritual civilization construction.

Index Level (C)

Index C_1 is the rational use of underground space, that is the full use of underground space for fixed customers and visitors to park, and effective deployment of parking spaces, realizing optimization of the ground space; Index C_2 is the rational use of roof resources, that is to set up the roof greening or place the equipment on the roof, effectively saving the ground space, and calculating the utilization of roof resources; Index C_3 is the green rate, that is, the percentage of green area in total area; Index C_4 is the maintenance of green facilities, that is, the rational allocation of green, as well as the maintenance frequency; The index C_5 is the maintenance of energy saving facilities, that is, the rate and the level of the utilization of energy saving facilities; Index C_6 is energy recovery; Index C_7 is the energy recycling rate; C_8 is the use of renewable resources, that is the utilizing rate of making full use of renewable resources; Index C_9 is the building of atmosphere and environment of the district, that is whether the environment is good or bad; Index C_{10} is reduction of noise pollution, that is whether there is noise pollution monitoring platform, as well as its effect; Index C_{11} is measure for reducing air pollution, that is whether there is air pollution monitoring platform, as well as its the effect; Index C_{12} is garbage recycling, that is, the classification of garbage collection, rewards and punishments; Index C_{13} is environmental cleaning and protection, namely environmental cleaning frequency, effect and duration; Index C_{14} is indoor air quality, namely the proportion of indoor non harmful gas; Index C_{15} is indoor carbon dioxide monitoring, namely the proportion of indoor carbon dioxide; Index C_{16} is indoor light environment, that is, the indoor lighting area; Index C_{17} is indoor acoustic environment, that is whether there is indoor noise pollution; Index C_{18} is the long-term pollution control, namely the measures to control environment pollution; Index C_{19} is tracking and monitoring of environmental protection performance, that is, whether the environmental protection measures are reasonable and effective; Index C_{20} is the control of pollution sources in latter stage, which is the control measures of pollution sources; Index C_{21} is the frequency of sports activities, which is to improve the physical quality and cultural quality of the residents. Index C_{22} is mental health counseling, that is, whether there is mental health counseling and its professional standards. The concrete evaluation index system is shown in Figure 1.

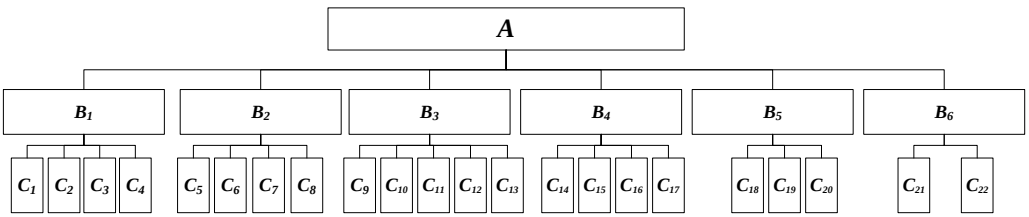

Figure 1. Evaluation index system of property management of green building.

A evaluation effect of property management

B_1 land saving and green facilities

B_2 water saving, energy saving and energy utilization

B_3 environment making and environment protection

B_4 Indoor environmental quality

B_5 long-term environmental protection value

B_6 spiritual civilization construction

C_1 rational use of underground space,

C_2 rational use of roof resources

C_3 green rate

C_4 maintenance of green facilities

C_5maintenance of energy saving facilities

C_6 energy recovery

C_7 energy recycling rate

C_8 use of renewable resources

C_9 building of atmosphere and environment of the district

C_{10} reduction of noise pollution

C_{11} measures for reducing air pollution,

C_{12} garbage recycling

C_{13} environmental cleaning and protection

C_{14} indoor air quality

C_{15} indoor carbon dioxide monitoring

C_{16} indoor light environment

C_{17} indoor acoustic environment

C_{18} long-term pollution control

C_{19} tracking and monitoring of environmental protection performance

C_{20} control of pollution sources in latter stage

C_{21} frequency of sports activities

C_{22} mental health counseling

DETERMINATION OF THE WEIGHT OF EVALUATION INDEX

Construction of Judgment Matrix

Use AHP method to construct the judgment matrix. In the same level, make pair-wise comparison between indexes which have direct relationship with some index in upper level. According relative important levels, assign each index with its judgment value b_{ij} by scales of 0, 1, 2. When i is more important than j, the value is 2; when i and j are equally important, value is 1; when i is less important than j, value is 0. In this way, the initial judgment matrix can be gotten. The ranking index to calculate the weights of each index is:

$$h_i = \sum_{j=1}^{n} b_{ij}$$

Compare the maximum value $h_{\max}$ with minimum value $h_{\min}$ in h_i with scales 1-9 (seeing in Table 10) and then the importance scale h_m of the basic points (greater than 1) is gotten. Then, use the following formula:

$$b'_{ij} = \begin{cases} \dfrac{h_i - h_j}{h_{\max} - h_{\min}}(h_m - 1) + 1 \quad (h_i \geq h_j) \\ \dfrac{h_i - h_j}{h_{\max} - h_{\min}}(h_m{}^{-1}) + 1 \quad (h_i < h_j) \end{cases}$$

$$h_{\max} = 7, h_{\min} = 3, h_m = 4$$

Convert the initial judgment matrix of three scales into a formal judgment matrix. Then the following Tables 1 to 9 can be gotten:

Table 1. Judgment matrix with 9 scales and its contents.

Scale	Content
1	Two indexes are equally important
3	0ne index is lightly more important that the other one
5	One index is obviously more important that the other one
7	One index is much more important that the other one
9	One index is extremely more important that the other one
2, 4, 6, 8	The median of the above two adjacent judgments

Table 2. Initial judgment matrix of (B_1-C).

B_1	C_1	C_2	C_3	C_4	h_i
C_1	1	2	2	2	7
C_2	0	1	1	2	4
C_3	0	2	0	1	3
C_4	1	0	2	1	4

Table 3. Final judgment matrix of (B1-C).

B_1	C_1	C_2	C_3	C_4
C_1	1.00	3.16	3.82	5.01
C_2	0.14	1.00	1.58	3.73
C_3	0.23	2.09	1.00	1.23
C_4	1.00	0.14	3.46	1.00

Table 4. Final judgment matrix of (A-B).

A	B_1	B_2	B_3	B_4	B_5	B_6
B_1	1.00	2.65	3.82	1.01	0.57	3.71
B_2	0.19	1.00	1.56	3.73	1.43	0.51
B_3	0.37	1.09	1.00	3.61	1.23	4.17
B_4	0.36	2.51	4.69	1.00	0.42	2.58
B_5	0.84	3.37	5.13	3.54	1.00	0.36
B_6	1.03	0.59	3.11	1.22	0.15	1.00

Table 5. Final judgment matrix of (B2-C).

B_2	C_5	C_6	C_7	C_8
C_5	1.00	3.41	1.82	4.01
C_6	1.14	1.00	3.58	5.13
C_7	0.23	1.09	1.00	3.23
C_8	0.17	2.14	3.46	1.00

Table 6. Final judgment matrix of (B3-C).

B_3	C_9	C_{10}	C_{11}	C_{12}
C_9	1.00	1.54	3.42	1.01
C_{10}	0.14	1.00	2.58	4.73
C_{11}	0.45	2.11	1.00	1.23
C_{12}	1.00	0.14	3.46	1.00

Table 7. Final judgment matrix of (B4-C).

B_4	C_{13}	C_{14}	C_{15}	C_{16}	C_{17}
C_{13}	1.00	3.16	5.01	3.61	2.34
C_{14}	0.19	1.00	1.64	3.23	1.84
C_{15}	0.74	0.22	1.00	1.70	0.56
C_{16}	0.45	0.56	0.20	1.00	0.39
C_{17}	1.40	0.28	0.28	1.60	1.00

Table 8. Final judgment matrix of (B_5-C).

B_5	C_{18}	C_{19}	C_{20}
C_{18}	1.00	1.40	0.36
C_{19}	0.61	1.00	1.80
C_{20}	3.10	4.00	1.00

Table 9. Final judgment matrix of (B6-C).

B_6	C_{21}	C_{22}
C_{21}	1.00	4.00
C_{22}	0.29	1.00

Consistency Checking

Consistency check for single weight. In this paper, the mean random consistency index proposed by A. L. Saaty is used to test the consistency of the judgment matrix (mean random consistency index is shown in Table 10). According to each mean random consistency index, work out the consistency index CI of the judgment matrix, the random consistency ratio CR=CI/R. If CR<0.10, the matrix is considered to be consistent; otherwise, it is necessary to re-adjust the matrix, until the matrix owns a satisfactory consistency.

Table 10. Mean random consistency index of judgment matrix.

matrix order	1	2	3	4	5	6	7	8	9
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45

The specific steps are as follows:

(1) Use square root method to calculate, let:

$$\overline{w}_i = 3\sqrt{\prod_{j=1}^{n} b'_{ij}} \qquad (i = 1, \cdots, n)$$

$$w_i = \overline{w}_i / \sum_{i=1}^{n} \overline{w}_i \qquad (i = 1, \cdots, n)$$

$$\boldsymbol{B_i} = \sum_{i=1}^{n} b'_{ij} w_i \qquad (i = 1, \cdots, n)$$

Single weight: $\boldsymbol{W} = (w_1, w_2, \cdots w_n)^{\mathrm{T}}$;

Maximum eigenvalue: $\lambda_{\max} = \sum_{i=1}^{n} \frac{\boldsymbol{B_i}}{n w_i}$; $CI = (\lambda_{\max} - n)/(n-1)$;

(2) Select the value of RI according to Table 10, and get the consistency index CR from CR=CI/RI;

(3) Calculate the judgment matrix and judge whether CR is less than/equal to 0.01, namely judge whether the judgment matrix owns a satisfactory consistency; if not, adjust the matrix.

Based on the above steps, in the judgment matrix A-B, there are: $\boldsymbol{W_{A\text{-}B}}$=(0.69, 0.145, 0.48, 0.299, 0.064, 0.227), $\lambda_{\max}$ =6.59, *CI*=0.0118, *RI*=1.24, *CR*=0.0105 < 0.10.

In the judgment matrix B_1-C, there are:$\boldsymbol{W_{B1\text{-}C}}$=(0.73, 0.31, 0.154, 0.312), $\lambda_{\max}$ =4.06, *CI*=0.02, *RI*=0.9, *CR*=0.022 < 0.10.

In the judgment matrix B_2-C, there are:$\boldsymbol{W_{B2\text{-}C}}$=(0.54, 0.147, 0.82, 0.209,), $\lambda_{\max}$ =4.13, *CI*=0.043, *RI*=0.9, *CR*=0.048 < 0.10.

In the judgment matrix B_3-C, there are:$\boldsymbol{W_{B3\text{-}C}}$=(0.55, 0.13, 0.61, 0.119, 0.064), $\lambda_{\max}$ =5.39, *CI*=0.0975, *RI*=1.12, *CR*=0.087 < 0.10.

In the judgment matrix B_4-C, there are $\boldsymbol{W_{B4\text{-}C}}$=(0.73, 0.215, 0.381, 0.459), $\lambda_{\max}$ =4.24, *CI*=0.08, *RI*=0.9, *CR*=0.0889 < 0.10.

In the judgment matrix B_5-C, there are $\boldsymbol{W_{B5\text{-}C}}$=(0.41, 0.375, 0.015), $\lambda_{\max}$ =3.07, *CI*=0.035, *RI*=0.58, *CR*=0.0603 < 0.10.

In the judgment matrix B_6-C, there are $\boldsymbol{W_{B6\text{-}C}}$=(0.028, 0.395), $\lambda_{\max}$ =2, *CI*=0, *CR*=0 < 0.10.

The calculating steps are same with the above steps, the results are: $\boldsymbol{W}$ =(0.24, 0.39, 0.551, 0.64, 0.256, 0.65, 0.546, 0.64, 0.114, 0.39, 0.645, 0.214, 0.238, 0.77, 0.81, 0.96, 0.73, 0.31, 0.154, 0.312, 0.224,0.36,0.41), *CR*=0.0491 < 0.10.

EVALUATION METHODS

For each index of the measures, according to the custom, evaluations can be divided into the 5 grades, namely very satisfied, satisfied, relatively satisfied, not very satisfied, not satisfied; according to the specific property management mode, determine the subjection degree of each index to the 5 evaluation grades, thus establishing obscure evaluation matrix P; then according to $B=W^{T}P$, where B represents subjection degree of each index to the 5 evaluation grades; calculate the results of obscure judgments; finally, according to D=BC where C represents the column vector

composed of scores of the 5 evaluation grades in 10 points system, the final score of the evaluated object can be obtained; through the above steps, evaluation on the property management system of green building can be made.

CONCLUSION

This paper, with the combination of theory and practice, according to the actual problem of green building in the operation, through the analytic hierarchy process, complete the theory research on evaluation system of green building property management. It makes initial research on property management of green from several aspects, such as water saving, energy saving, materials saving, environmental protection, lighting and so on. Using the proposed property management system of green building, can solve the practical problems of the property management of green building in current stage, and make the property management of green building more efficient. And the proposed management system solves such problems as incomplete indexes the management of public buildings, the lack of detailed classification and difficulty in reflecting the characteristics and goals of green building operations management. In the evaluation system indexes, the effect of green building operation management is correctly evaluated by quantitative index. Property management of green building is a brand new product and service, which is different from the traditional operation method of property management. It is a main research content to study how to help property management companies to improve their management concept, management system, and management technology in the future.

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