Study on Passive Building Promotion Barriers

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Abstract. This paper conducts in-depth research and discussion on the main obstacles to the development of passive buildings in China. Through reading relevant literature and combining expert opinions, this survey compiled a total of 18 independent and non-subordinated influencing factors from the four dimensions of technology, economy, policy and environment. Using questionnaires and key interviews to obtain first-hand data, the survey results can provide an effective reference for the promotion and development of passive buildings. The results of data analysis show that the deep influencing factors that hinder the promotion of passive architecture are lack of policy, and "lower attention of architectural designers" is an important factor hindering passive development.

Keywords: Passive building; coping mechanism; principal component analysis; Promotion barriers.

1. Introduction

Passive architecture was proposed in a discussion in 1988. The idea came from Professor Bo Adamson of Lund University in Sweden and Wolfgang Feist of the German Institute of Passive Buildings. The idea of passive architecture has been applied to all aspects. For example, the combination of reversible heat pump and passive building ideas enhances energy efficiency [1]. When improving fattening efficiency, solar shading and capture are combined with integrated grounding tubes to promote heat exchange with fresh air to reduce summer and The extreme internal temperature in winter [2], the subway station building group pipeline uses passive ideas to improve performance[3]. The construction of passive buildings in different regions is different. For example, the passive housing construction in southern Brazil determines the thermal encapsulation structure of different climates in southern Brazil from the baseline according to the basic performance standards [4]. Belgian houses are more tested for housing utilization and utilization. Passive thinking is used to do universal design [5], the Iberian Peninsula adopts passive cooling to achieve energy efficiency in houses [6], and even the Arctic region adopts fluid dynamics technology to achieve indoor hot air [7]. The development of passive houses is inseparable from the development of new building materials, phase change material wall panels to achieve optimal control of passive indoors [8], wood-GPDE-PCM nanocapsule floor is used for passive cooling in passive buildings [9], and Passive building design combined with photovoltaic applications to promote low-energy high-rise buildings [10]. In view of the current development of passive buildings, this survey investigates the main obstacles from the four dimensions of technology, economy, policy and environment, and summarizes its current shortcomings.

2. Research Strategy

2.1 Questionnaire Design

Establishing an evaluation index system for obstacles in passive building promotion is the key to implementing evaluation. The reasonableness of the system setting is directly related to the accuracy of the evaluation results. Therefore, the basic principles that must be followed when selecting indicators for promotion factors include: 1. Scientific principles, 2. Feasibility principle, 3. Comprehensive principle, 4. Principle of difference, 5. stability principle.

2.2 Questionnaire Pre-investigation and Improvement

In order to conduct on-the-spot inspection of the content of the survey program and understand whether the survey work arrangement is reasonable, the team conducted a pre-survey test on the questionnaire. The survey targets designers and real estate developers of architectural design institutes involved in passive building-related projects. The survey was conducted in the form of offline distribution, mainly for architectural design institutes participating in passive construction projects.

2.3 Obstacle Factors

2.3.1 Technical Dimensions

1.Standardization 2.Building Materials and Components
3.Technical Difficulties 4.basic research 5.professional talents

2.3.2 Economic Dimension

1.economic cost 2.construction cost 3.selling price
4.Consumer recognition 5.market share 6.demonstration publicity

2.3.3 Policy Dimensions

1. Mandatory Policy 2.Incentive Policy
3.Scientific Research Support 4.Supervision

2.3.4 Environmental Dimensions

1.Emphasis 2.Climate Characteristics 3.Energy Conservation Consciousness

3. Data Analysis

The technical, economic, policy, and environmental barriers are respectively set to E, F, L, and M, and the obstacle indicators are assigned to the definition by a label. For example, the standardization is set to $E_1$and the survey results are analyzed using principal component analysis in combination with questionnaire data.Through the analysis of the data in this paper, the KMO value is greater than 0.9, and the Bartley sphere test with a significance level of 0.05 is passed, indicating that the questionnaire structure is good and can be factor analysis.

Table 1. Bartley ball test

KMO sampling suitability		0.927
Bartlett sphericity test	Approximate chi square	2828.884
	Degree of freedom	153
	Significant	.000

3.1 Principal Component Analysis

Based on the questionnaire, the three main components of the obstacle reduction factor are obtained:

$$A_1=0.373*E_1+0.414*E_2+0.310*E_3+0.376*E_4+0.328*E_5+0.332*F_1+0.277*F_2+0.286*F_3+0.380*F_4+0.526*F_5+0.524*F_6+0.691*L_1+0.827*L_2+0.812*L_3+0.724*L_4+0.788*M_1+0.670*M_2+0.621*M_3 \quad (1)$$

A_2=0.779*E_1+0.770*E_2+0.808*E_3+0.746*E_4+0.720*E_5+0.389*F_1+0.322*F_2+0.301*F_3+0.223*F_4 +0.145*F_5+0.187*F_6+0.197*L_1+0.223*L_2+0.282*L_3+0.422* L_4+0.393* M_1+0.378*M_2+0.435*M_3 (2)

A_3=0.311*E_1+0.268*E_2+0.289*E_3+0.240*E_4+0.402*E_5+0.631*F_1+0.763*F_2+0.813*F_3+0.763*F_4 +0.705*F_5+0.634*F_6+0.387*L_1+0.358*L_2+0.300*L_3+0.136L_4+0.145*M_1+0.219*M_2+0.240*M_3(3)

3.2 The Principal Component Variance Contribution Rate Model has a Comprehensive Evaluation Function

3.2.1 Coefficient of Variation of the Original Variable

$$P = (P_1 + P_2 + P_3 + , , , , , , P_{18}) \quad (4)$$

3.2.2 Principal Component Variance Contribution Rate Model

$$B = (B_1 + B_2 + B_3 + , , , , , , B_{18}) \quad (5)$$

3.2.3 Determining the Weight of the Original Indicator Variable by the Definition of the Coefficient of Weighted Comprehensive Evaluation Model

$$W_1 = \frac{B_j P_j}{\sum_{j=1}^{11} |B_j| P_j} = 0.035 \quad (6)$$

$$W = (W_1 + W_2 + W_3 + , , , , , , W_{18}) \quad (7)$$

3.2.4 The Comprehensive Evaluation Function

Y=0.035*E_1+0.036*E_2+0.035*E_3+0.044*E_4+0.043*E_5+0.056*F_1+0.027*F_2+0.026*F_3+0.049*F_4+ 0.065*F_5+0.061*F_6+0.084*L_1+0.078*L_2+0.073*L_3+0.079*L_4+0.074*M_1+0.073*M_2+0.064*M_3(8)

4. Theoretical Discussion

On the basis of the MICMAC method, the correlation analysis of the reduced-index related indicators is carried out, and the decomposition of each layer is carried out according to the principle of T(n_i)=Q(n_i), and the hierarchical correlation analysis is performed on the six main indicators we obtained. Determine the adjacency matrix of these six main obstacle factors, and use MATLAB to perform the Boolean number multiplication operation to obtain the reachable matrix M.

According to the results of principal component analysis, the most important six indicators are set to F12 to F17.

Table 2. Reachable matrix

factor	F12	F13	F14	F15	F16	F17	Driving force
F12	1	1	1	1	1	0	5
F13	0	1	1	0	1	0	3
F14	0	1	1	0	1	0	3
F15	0	0	0	1	0	0	1
F16	0	0	0	0	1	0	1
F17	0	0	0	0	0	1	1
Dependence	1	3	3	2	4	1	

(1) I Independent type: The climatically characterized obstacles have strong independence and are uncontrollable for nature. Regulatory power is also more dependent on its own attributes.

(2) II Self-style: The mandatory policy obstacles have a greater impact on other factors, while other factors are difficult to determine the trend of mandatory policies, which reflects its Very high self-style.

(3) III Dependent type: The factors of attention degree are greatly affected by other obstacles, and the degree of attention has little feedback effect on other obstacles.

(4) IV Linkage type: Incentive policies and research support are greatly influenced by other obstacles, and have a strong influence on other factors, and have strong correlation.

5. Conclusion

According to the survey, 42% of respondents are completely unaware of passive buildings, and 25% of respondents are at a stage that passive buildings are heard but not well understood. It can be seen that the related concepts of passive architecture have not penetrated into the minds of ordinary people. If people can't touch and understand that passive buildings are better than ordinary buildings, they can't understand the important role of passive buildings in environmental improvement. Blocking its choice of passive buildings. The low awareness of the people is a major obstacle to the promotion of passive buildings. The main obstacles are small to large in terms of climate characteristics, scientific research strength, emphasis, incentive policies, supervision, and mandatory policies. In addition to the objective factor of China's climate characteristics, four indicators belong to the policy dimension, and the remaining one is “the degree of emphasis of designers”. It can be seen that “the lack of policy” and “the degree of designer attention” have become the main factors hindering the promotion of passive architecture.

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