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Analyzing Technical Barriers to Green Farmhouse Construction in China: A DEMATEL-ISM-MICMAC Approach

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Abstract: The development of green farmhouse technology is crucial for advancing sustainable agricultural practices in China. However, the comprehensive promotion and effective implementation of green farmhouse construction are significantly hindered by the underdevelopment and immaturity of the required technologies. This study aims to identify and analyze the key factors that impede the development of green farmhouse technology and to elucidate the interrelationships among these factors. A systematic literature review was conducted to determine the primary barriers to green farmhouse technology development. The Decision-Making Trial and Evaluation Laboratory (DEMATEL) method was employed to examine the interdependencies among these factors, providing insight into their mutual influence and centrality. Subsequently, Interpretive Structural Modeling (ISM) was applied to establish a hierarchical structure, revealing the multi-level relationships among the identified barriers. Finally, the Multiplication of Cross-Impact Matrices (MICMAC) analysis was utilized to further categorize the factors based on their driving power and dependence. The findings indicate that the development of green building materials, research and development (R&D) funding, and technological expertise are the core factors impeding the advancement of green farmhouse technology. These barriers were classified into six hierarchical levels and grouped into four categories: autonomous, dependent, linked, and independent factors. Through the combined application of DEMATEL, ISM, and MICMAC, a comprehensive understanding of the hierarchical structure and the interrelationships among these barriers was achieved. The factors were further categorized into three groups: budget and funding constraints, green farmhouse technology R&D challenges, and technology promotion and selection obstacles. The insights derived from this study provide a theoretical foundation for developing strategies to overcome these impediments, thereby facilitating the broader adoption of green farmhouse technology in China.

Keywords: Green farmhouse technology; Technical barriers; Decision-Making Trial and Evaluation Laboratory (DEMATEL); Interpretive Structural Modeling (ISM); Multiplication of Cross-Impact Matrices (MICMAC)

1 Introduction

With the concept of sustainable development gaining popularity [1], green building has received widespread attention as an important way of energy conservation [2] and environmental protection [3]. Green farmhouse technology [4], with its potential to adapt to the characteristics of rural areas [5] and promote sustainable agricultural development [6], has become an important branch in the field of green building. However, the promotion and application of green farmhouse technology [7] faces many challenges and hindrances [8], and the existence of these hindrances seriously affects the effective implementation and popularization of green farmhouse technology.

Therefore, systematically analyzing and identifying these hindering factors is of great theoretical and practical significance to promote the development of green farmhouse technology.

Research on green farm buildings is crucial for enhancing the quality of farm structures [9], improving the living conditions of farmers [10], and achieving energy savings and emission reductions [11]. These efforts align with policy requirements for green development in urban and rural construction [12]. The existing literature primarily focuses on the design, materials, and energy-saving technologies of green buildings. Studies have investigated various aspects, such as green roofs [13, 14] and building envelopes [15, 16], to reduce energy consumption in buildings. Additionally, there has been research on sustainable building materials [17] and the relevant data associated with these materials [18], as well as the development of evaluation systems [19]. Although there have been studies focusing on the promotion and application of green building technologies, there is a relative scarcity of research specifically addressing green farmhouse technologies. Moreover, there is a notable lack of in-depth discussion on the specific impediments to their development. For example, Chan et al. [20] examined the critical barriers to adopting green building technologies in developing countries, specifically in the context of Ghana. Similarly, Wang et al. [21] evaluated the critical barriers to the adoption of green construction technologies in China. Wang et al. [22] conducted an empirical analysis of the factors influencing the adoption and diffusion of green building technologies, while Tran et al. [23] empirically examined the factors affecting the adoption of green building technologies from the perspective of construction developers. Furthermore, most existing studies have relied on qualitative analyses, lacking systematic and quantitative research approaches. This limitation makes it challenging to comprehensively understand and reveal the complex issues associated with the development of green farmhouse technologies.

Table 1. Indicators of technological impediments to green farmhouse

Primary Indicators	Secondary Indicators	Interpretation of Indicators	Literature Support
Capital	R&D technology funding A_1	Lack of funding for R&D-related technologies.	[24, 25]
	Funding channels for agricultural housing A_2	Limited channels for mobilizing funds for agricultural housing construction.	[26–28]
Budget	Farmers' income A_3	Limited income and low budgets for farmers.	[29–31]
Technical promotion	Technical experience A_4	Lack of experience in building green farmhouses.	[32]
	Technician A_5	Shortage of relevant technical staff and low penetration of construction technology.	[33, 34]
Appropriate technology	Appropriate Construction Technology A_6	Lack of locally appropriate construction techniques.	[35]
	Appropriate Water Treatment Technology A_7	Low integration of water treatment technologies into local conditions.	[36]
	Suitable building materials A_8	Lack of locally relevant green building materials.	[37–39]
	Appropriate energy-saving technologies A_9	Low integration of energy-efficient technologies with local realities.	[40–42]
Technical R&D	Building Technology R&D A_{10}	Insufficient R&D of green building technologies.	[43–45]
	Water treatment system R&D A_{11}	Inadequate establishment of water treatment systems and insufficient R&D of related technologies.	[46–48]
	R&D of energy-saving technologies A_{12}	Insufficient R&D of energy-saving technologies.	[49–51]
Green building material	Building Materials R&D A_{13}	Insufficient R&D of green building materials.	[52–54]
	Building materials market A_{14}	Green building materials in the building materials market are of varying quality, instability, and limited purchasing channels.	[9, 54, 55]
Practical effect	Green technology effect A_{15}	Instability and uncertainty in the practical effects of green technologies.	[56–58]

This study will further enrich the research in this area. Three analytical methods were used: DEMATEL, ISM, and MICMAC. The use of the DEMATEL method revealed the relative importance of the factors and their impact on the overall system; the ISM technique was applied to parse the hierarchical structure within the system and to map out the influence relationship diagram; and the MICMAC analysis further refined the interactions between the factors and provided a more precise description of the system's relationships. Since the use of a single method can, to a certain extent, affect the hierarchical structure and the fineness of the relationships among factors, this study combines the three methods to effectively leverage their complementary advantages and disadvantages. This approach results in a clearer system structure and a deeper understanding of the relationships and interdependencies of the factors in complex systems. This study will provide a scientific basis and decision support for the promotion and application of green farmhouse technology by examining the hindering factors affecting green farmhouse construction technology, thereby promoting the sustainable development of rural areas.

2 Identifying Factor

This study collects relevant literature on green farmhouse technology by querying databases such as CNKI, Elsevier, Springer, Web of Science, and so on, screens them by reading the titles and abstracts of the literature, and then classifies and summarizes them in a relevant way and identifies 15 impediments to the development of green farmhouse technology, as shown in Table 1.

3 Methodologies

This study was divided into three main stages. First, the hindering factors of green farmhouse construction technology were identified through the literature review; second, the indicator correction was carried out, including the development of a questionnaire and inviting experts to score; finally, in the third stage, three analytical methods, namely, DEMATEL, ISM, and MICMAC, were used to explore the interrelationships among the hindering factors in depth, and a multilayer recursive model was constructed to categorize these factors into four clusters, which were plotted as charts [59]. The research steps are shown in Figure 1.

3.1 Stage 1: Identification of Impeding Factors Affecting Green Farm Building Technologies Through Literature

In this study, relevant literature were searched through databases such as Web of Science, Elsevier, Springer, CNKI, and the combination of keywords such as green farmhouse/building construction technology, GBTS, hindering factors, and construction status.

3.2 Stage 2: Revision of Indicators

The Delphi Method, the full name of which is "Delphi Method", is a forecasting method that uses communication to solicit expert opinions. The Delphi Method was pioneered by Olaf Helmer and Norman Dalkey in the 1940s and further developed by the RAND Corporation.

By specifying the questionnaire, which contains the expert self-assessment form, the evaluation of the importance of the indicator, and the expert's opinion of modification, the results are statistically analyzed according to the questionnaire obtained, and then the direction of modification of the indicator is derived, in which the modification of the indicator involves the following perspectives.

(1) Degree of expert authority

The degree of expert authority C_a is mainly determined by the basis of expert judgment in the expert self-assessment form C_b and the degree of familiarity C_d.

$$C_a = (C_b + C_d)/2 \tag{1}$$

(2) Degree of expert concentration

The degree of expert concentration is determined by the importance mean and the full frequency of the score.

① Importance mean C_j : the greater the importance mean C_j, the higher the importance of the corresponding j indicator.

$$C_j = (1/m_j) \times \sum_{i=1}^{m} A_{ij} \tag{2}$$

where, m_j is the number of experts participating in the evaluation of the jth indicator, and A_{ij} is the rating value of the jth indicator by the ith expert.

② Full frequency N_i: for the full score frequency N_i, the larger it is, the higher the importance of the corresponding indicator of j.

$$N_i = m_i'/m_i \tag{3}$$

where, m_i' is the number of experts who participated in the ith indicator giving full marks, and m_i is the number of experts who participated in the ith indicator.

(3) Degree of expert coordination

The expert harmonization degree is determined by the coefficient of variation K_j and the standard deviation of the indicator scores S_j.

Coefficient of variation K_j: The coefficient of variation K_j reflects the degree of dispersion of the data distribution.

$$K_j = S_j/C_j \tag{4}$$

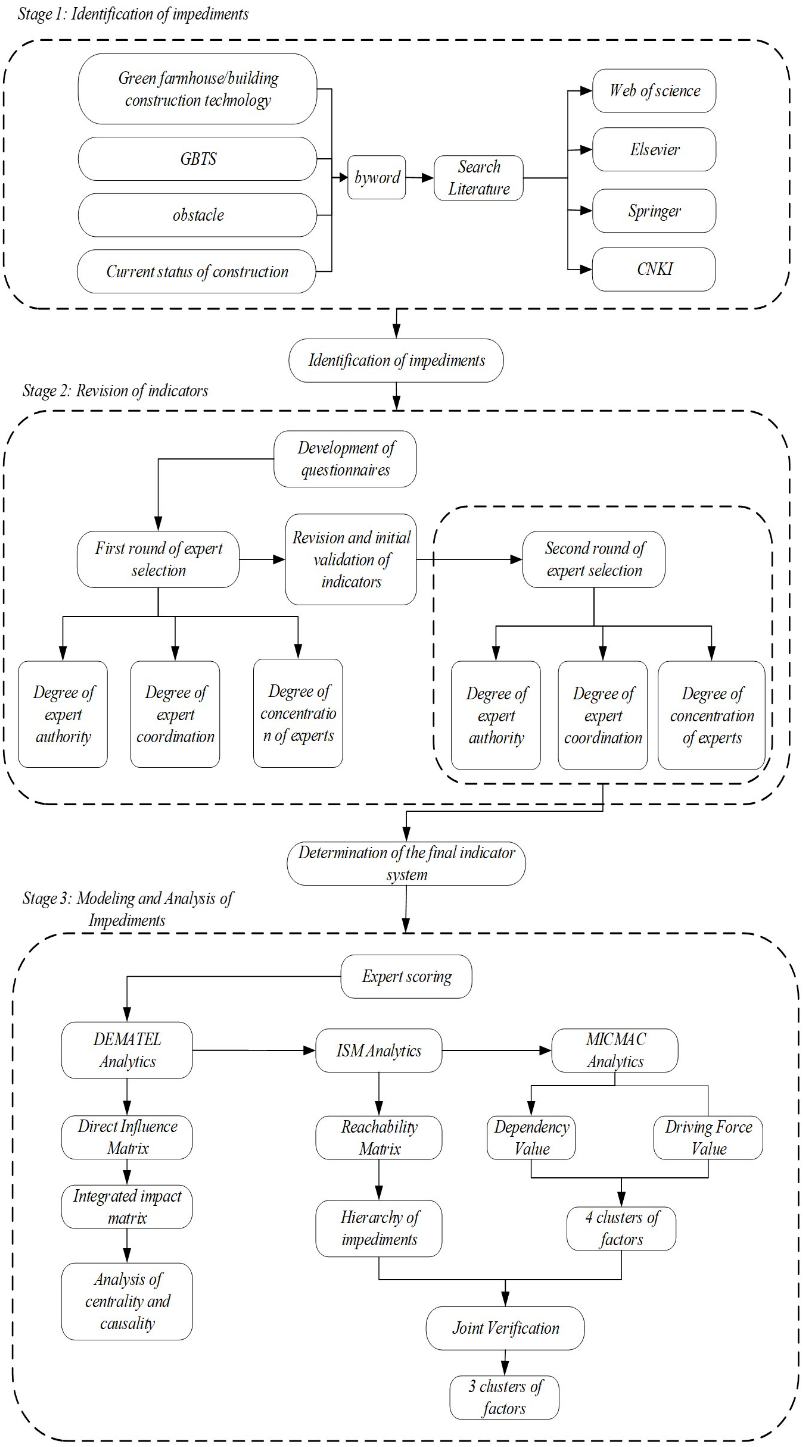

Figure 1. Steps of the research

3.3 Stage 3: Analysis of Impediments Through the Combined Use of DEMATEL, ISM, and MICMAC

The DEMATEL method, originally proposed in 1972 by André Gabus and Eduard Fontela of the Battelle Geneva Research Center in Geneva, Switzerland, is an effective system analysis method. It is an effective system analysis method, based on expert knowledge, the use of tools such as matrix and graph theory to derive the corresponding matrix results and casual loop diagram, and to analyze the interdependence between factors and the degree of influence on the system. ISM was proposed by the American scholar J. P. Warfield in the 1970s, and is a method of constructing multi-level recursive models that analyzes the interrelationships between factors in complex systems by using the principles of correlation matrices and graph theory. In this way, ISM determines the hierarchy of factors in a system and the intrinsic mechanism of action between factors. MICMAC, originally proposed by French scholars in the 1970s, but the name of the specific originator is not clearly documented, is a quantitative analytical that analyzes the driving force and dependence of each factor by using the method of matrix multiplication, and then categorizes the factors according to dependence, association, autonomy, and independence, thus demonstrating the position and role of each factor in the system.

The combination of DEMATEL-ISM-MICMAC three methods makes the relationship of factors in the system structure clearer and the structure is more three-dimensional; DEMATEL can effectively reflect the primary and secondary relationship between the factors and the degree of influence on the system; ISM can analyze the hierarchical structure of the system and draw a rough influence relationship diagram; MICMAC further refines the influences between factors, and can more accurately describe the system relationship. The combination of DEMATEL, ISM, and MICMAC analysis enhances the in-depth understanding of the internal structure of the system, and through this multi-dimensional analysis framework, the interactions and dependencies among the factors in the system can be more comprehensively identified and understood, which provides a powerful support for solving complex problems and making decisions.

The specific steps are as follows:

(1) Construct the direct impact matrix A.

$$A = \lfloor a_{ij} \rfloor_{mn}, i = 1, 2, 3, \cdots m, j = 1, 2, 3, \cdots n \tag{5}$$

Using the expert scoring method, the relationship and degree of influence between the technological impediments to green farmhouses were studied.

where, factor a_{ij} represents the extent to which ai affects a_j.

(2) Standardized direct impact matrix D. Normalize the direct impact matrix K to standardized direct impact matrix D.

$$D = \frac{A}{h}, h = \max \left[\sum_{i=1}^{m} a_{ij}, \sum_{j=1}^{n} a_{ij} \right] \tag{6}$$

(3) Construct a composite impact matrix K. This matrix represents the relationship and degree of influence between the factors.

$$K = D(E - D)^{-1} \tag{7}$$

where, E is the unit matrix.

(4) Calculate the degree of centrality M_i and the degree of cause N_i.

$$M_i = B_i + C_i \tag{8}$$

$$N_i = B_i - C_i \tag{9}$$

where, $B_i = \sum_{j=1}^{n} k_{ij}, \quad C_i = \sum_{i=1}^{m} k_{ij}$.

(5) Constructing the adjacency matrix H

Threshold α is introduced to eliminate the relationship between factors with small influence intensity, and matrix H is processed by threshold α to obtain the adjacency matrix H.

$$h_{ij} = \begin{cases} 1, k_{ij} \geq \alpha(i = 1, 2, 3, \cdots, m, j = 1, 2, 3, \cdots n) \\ 0, k_{ij} \leq \alpha(i = 1, 2, 3, \cdots, m, j = 1, 2, 3, \cdots n) \end{cases} \tag{10}$$

where, α is the sum of the means and standard deviations of all impact values in the composite impact matrix K.

(6) Constructing a reachability matrix T

Based on the arithmetic properties of Boolean matrices, use MATLAB software to perform multiple Boolean operations on the matrices.

$$T = (H + E)^{n+1} = (H + E)^{n} \neq (H + E)^{n-1} \neq H + E \tag{11}$$

where, E is the unit matrix.

(7) Create reachability set, antecedent set, and intersection

$$R(X_i) = \{X_i \mid X_i \in T, t_{ij} = 1\} \tag{12}$$

$$Q(X_i) = \{X_i \mid X_i \in T, t_{ji} = 1\} \tag{13}$$

$$W(S_i) = R(X_i) \cap Q(X_i) \tag{14}$$

where,

R(X_i) is the Reachability set, the set of elements in the reachable matrix for an element corresponding to behavior 1;

Q(X_j) is the Antecedent set, the set of elements in the reachable matrix whose corresponding column is 1;

W(S_i) is the Intersection, the reachable set and the set of antecedents.

(8) Constructing multilayer recursive models

With $\mathrm{W(S}_i) = \mathrm{R(X}_i)$ as the basis of hierarchical division, extract the first level of factors, and then the factors in the reachable matrix corresponding to the corresponding rows and columns, and repeat this process of structural hierarchical division of the reachable matrix, to construct a multilayer recursive order model.

(9) Calculate the driving force value P_i and dependency values O_i

$$P_i = \sum_{i=1}^{m} t_{ij} \tag{15}$$

$$O_i = \sum_{j=1}^{n} t_{ij} \tag{16}$$

(10) Charting Driving Force Values - Dependency Values

4 Result

First, based on the preliminary construction of the evaluation index system, this study formulated an expert questionnaire and sent it to experts in relevant fields via email. The collected data from the questionnaire were then summarized and analyzed. The questionnaire is divided into three main parts: the first part covers the basic information of the experts, the second part involves the evaluation of the importance of the indicators, and the third part is a self-assessment by the experts. The scoring method for the evaluation of indicators is based on a five-point Likert scale, where experts rate the importance of the indicators from "very unimportant" to "very important," corresponding to scores of 1 to 5 points. Additionally, there is a self-assessment table for the experts' judgment. The values for judgment and familiarity in the experts' self-assessment form are provided in Table 2 and Table 3, respectively.

Table 2. Quantitative values for the basis of expert judgment

Basis of Judgment	**Degree of Influence on Expert Judgment**		
	Low	Medium	High
Practical experience	0.3	0.4	0.5
Theoretical analysis	0.1	0.2	0.3
Peer understanding	0.05	0.1	0.1
Intuitive judgment	0.05	0.1	0.1
Add up the total	0.5	0.8	1.0

In view of the selection of experts for this questionnaire survey, this study decided to send questionnaires through email to scholars with deep research in this research field. Two rounds of questionnaires were sent, and 12 questionnaires were sent in both rounds. In the end, 12 effective questionnaires were collected in both rounds, with an effective recovery rate of 100%, indicating that most experts attach importance to this aspect and actively participate in this study.

Table 3. Quantitative values of expert familiarity

Familiarity	Highly Unfamiliar	Unfamiliar	General	Familiar	Extremely Familiar
Quantitative Value	0.2	0.4	0.6	0.8	1.0

In the first round, due to the lack of accuracy and professionalism in the expression of some indicators in the indicator system, an expert gave an opinion on the modification of the indicators in this questionnaire, which was to change the secondary indicator "agricultural housing loan service" under the primary indicator "capital" to "agricultural housing capital channel". The revised indicator system is shown in Table 1.

In the second round, comprehensive expert authority degree, expert concentration degree, and coordination degree analysis expert rating evaluation, it was found that the experts had a high degree of agreement with the current indicator system and did not make any suggestions for adjusting it. Therefore, the current indicator system is reasonable, and there is no need for a third round of expert evaluation.

Table 4. Degree of centrality and cause of factors impeding to green farmhouse technology

Restraint	**ri**	**ci**	**Centrality**	**Degree of Cause**	**Driving Force Value**	**Dependent Value**
A1	1.556	0.908	2.464	0.648	5	5
A2	0.217	0.100	0.317	0.117	1	1
A3	1.258	0.000	1.258	1.258	7	1
A4	1.030	1.110	2.141	-0.080	7	6
A5	0.406	0.871	1.277	-0.465	2	6
A6	0.184	0.771	0.955	-0.588	1	3
A7	0.368	0.728	1.096	-0.360	2	3
A8	0.118	0.760	0.879	-0.642	1	4
A9	0.137	0.511	0.648	-0.375	1	2
A10	0.836	1.042	1.878	-0.206	5	5
A11	0.274	1.038	1.312	-0.765	2	5
A12	0.963	0.693	1.656	0.271	5	4
A13	1.707	0.868	2.575	0.839	8	5
A14	1.172	0.756	1.929	0.416	6	3
A15	0.656	0.725	1.381	-0.068	3	3

Table 5. The set of influencing factors of the reachable matrix

	Reachability Set	**Antecedent Set**	**Intersection**
A1	A1, A10, A11, A12, A13	A1, A10, A13, A14, A15	A1, A10, A13
A2	A2	A2	A2
A3	A3, A5, A10, A11, A12, A13, A14	A3	A3
A4	A4, A5, A8, A10, A11, A12, A13	A4, A5, A10, A12, A13, A14	A4, A5, A10, A12, A13
A5	A4, A5	A3, A4, A5, A10, A12, A13	A4, A5, A10, A12, A13
A6	A6	A6, A10, A13	A6
A7	A7, A11	A7, A11, A12	A7, A11
A8	A8	A4, A8, A13, A14	A8
A9	A9	A9, A12	A9
A10	A1, A4, A5, A6, A10	A1, A3, A4, A10, A15	A1, A4, A10
A11	A7, A11	A1, A3, A4, A7, A11	A7, A11
A12	A4, A5, A7, A9, A12	A1, A3, A4, A12	A4, A12
A13	A1, A4, A5, A6, A8, A13, A14, A15	A1, A3, A4, A13, A14	A 1, A 4, A 13, A 14
A14	A1, A4, A8, A13, A14, A15	A3, A13, A14	A13, A14
A15	A1, A10, A15	A13, A14, A15	A15

Then, according to the existing index system, this study made a questionnaire and invited experts to score the degree of influence among various factors, that is, from "great influence" to "little influence", they were assigned 1-5 points. The direct impact matrix (Formula 17) and comprehensive impact matrix (Formula 18) were obtained by using DEMATEL, and then the centrality and cause degree of each factor were obtained by analysis Table 4). The reachable set and the previous item set were extracted by ISM continuously (Table 5), and a six-level hierarchical structure was established (Figure 2). Finally, MICMAC was introduced to analyze the obstacle factors, which were divided into four groups of factors, and the MICMAC analysis quadrant diagram was drawn (Figure 3).

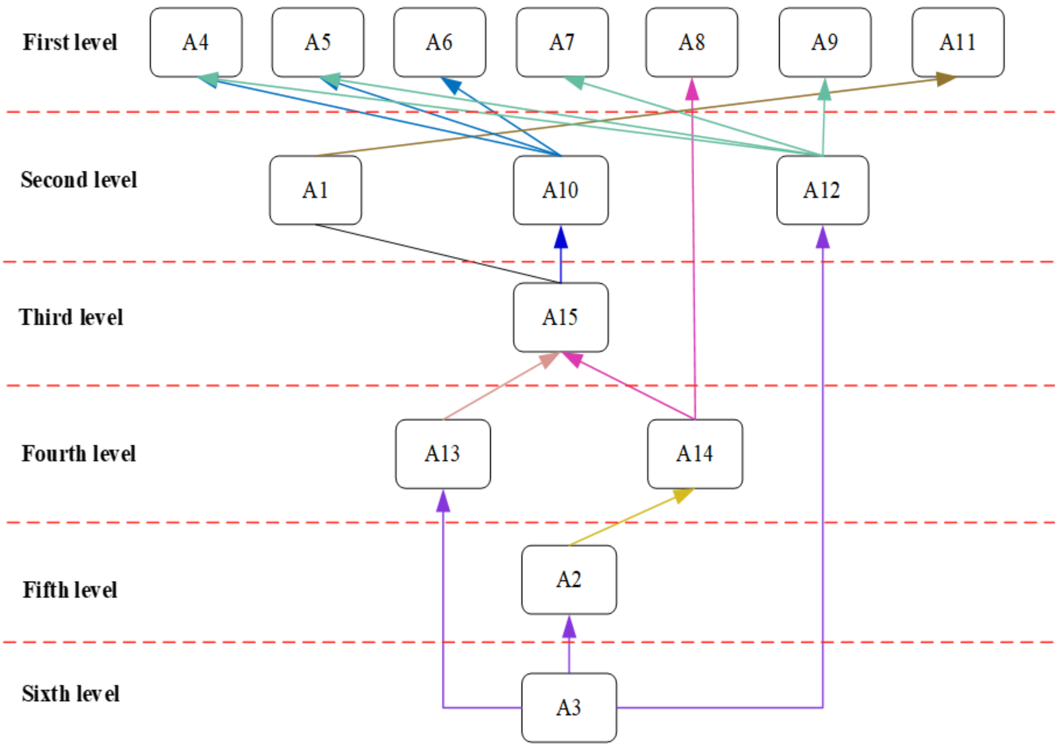

Figure 2. Hierarchical model of technical obstacles to green farmhouse

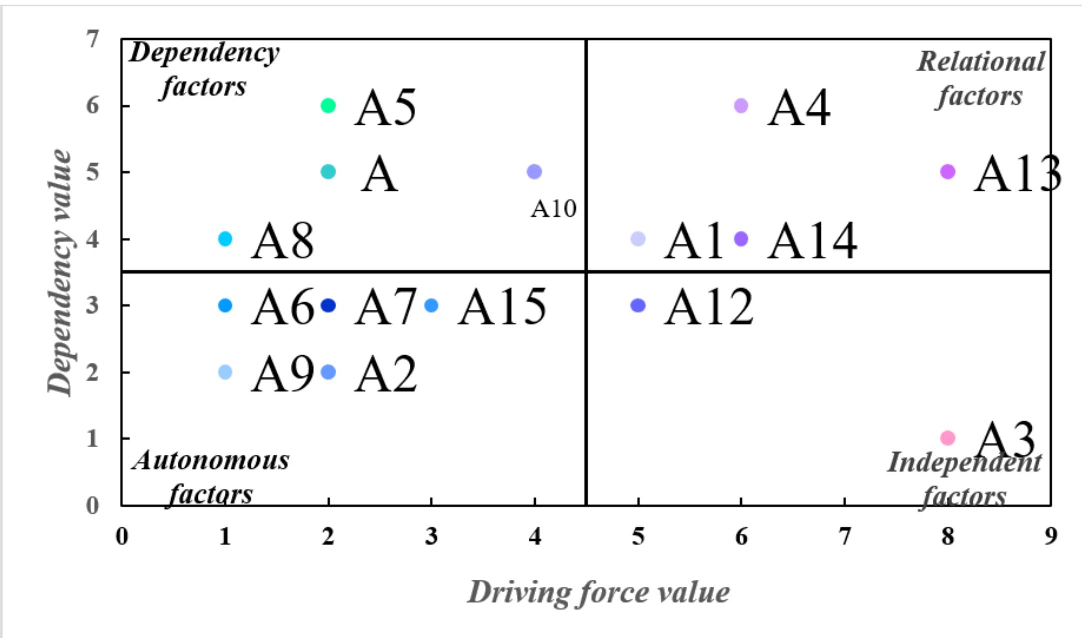

Figure 3. The MICMAC analysis results of technical obstacles to green farmhouses

Formula 17: Direct Impact Matrix

$$A = \begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 2 & 2 & 2 & 2 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 2 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 1 & 1 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 1 & 1 & 1 & 1 & 0 & 0 \\
0 & 0 & 0 & 2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 2 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 0 & 0 & 1 & 1 & 2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 0 & 0 & 1 & 1 & 0 & 1 & 0 & 2 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & 0 & 0 & 1 & 1 & 1 & 0 & 2 & 0 & 0 & 0 & 0 & 0 & 2 & 2 \\
1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 2 \\
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0
\end{bmatrix} \tag{17}$$

Formula 18: Integrated Impact Matrix

$$K = \begin{bmatrix}
0.080 & 0.000 & 0.000 & 0.090 & 0.078 & 0.077 & 0.076 & 0.060 & 0.053 & 0.238 & 0.240 & 0.225 & 0.230 & 0.052 & 0.056 \\
0.022 & 0.020 & 0.102 & 0.023 & 0.019 & 0.009 & 0.006 & 0.020 & 0.004 & 0.021 & 0.018 & 0.017 & 0.029 & 0.121 & 0.030 \\
0.061 & 0.204 & 0.020 & 0.085 & 0.150 & 0.046 & 0.041 & 0.052 & 0.029 & 0.133 & 0.131 & 0.123 & 0.138 & 0.156 & 0.059 \\
0.041 & 0.000 & 0.000 & 0.067 & 0.142 & 0.050 & 0.039 & 0.133 & 0.027 & 0.123 & 0.123 & 0.115 & 0.117 & 0.026 & 0.029 \\
0.008 & 0.000 & 0.000 & 0.213 & 0.028 & 0.010 & 0.008 & 0.027 & 0.005 & 0.025 & 0.025 & 0.023 & 0.023 & 0.005 & 0.006 \\
0.012 & 0.000 & 0.000 & 0.014 & 0.013 & 0.022 & 0.001 & 0.002 & 0.001 & 0.106 & 0.004 & 0.004 & 0.004 & 0.001 & 0.001 \\
0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.053 & 0.000 & 0.105 & 0.000 & 0.211 & 0.000 & 0.000 & 0.000 & 0.000 \\
0.001 & 0.000 & 0.000 & 0.001 & 0.001 & 0.102 & 0.000 & 0.000 & 0.000 & 0.011 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 \\
0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.105 & 0.000 & 0.011 & 0.000 & 0.021 & 0.000 & 0.000 & 0.000 & 0.000 \\
0.115 & 0.000 & 0.000 & 0.140 & 0.127 & 0.218 & 0.012 & 0.022 & 0.009 & 0.060 & 0.040 & 0.037 & 0.038 & 0.009 & 0.009 \\
0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.000 & 0.211 & 0.000 & 0.021 & 0.000 & 0.042 & 0.000 & 0.000 & 0.000 & 0.000 \\
0.113 & 0.000 & 0.000 & 0.137 & 0.125 & 0.014 & 0.139 & 0.022 & 0.221 & 0.039 & 0.064 & 0.036 & 0.037 & 0.008 & 0.009 \\
0.173 & 0.000 & 0.000 & 0.174 & 0.140 & 0.152 & 0.018 & 0.257 & 0.012 & 0.094 & 0.055 & 0.052 & 0.076 & 0.242 & 0.264 \\
0.157 & 0.000 & 0.000 & 0.141 & 0.041 & 0.045 & 0.015 & 0.150 & 0.011 & 0.074 & 0.048 & 0.045 & 0.151 & 0.054 & 0.241 \\
0.135 & 0.000 & 0.000 & 0.037 & 0.025 & 0.034 & 0.010 & 0.023 & 0.007 & 0.137 & 0.033 & 0.031 & 0.042 & 0.111 & 0.031
\end{bmatrix} \tag{18}$$

5 Analyze

5.1 Analysis of the Results of the Correction of Indicators Based on the Delphi Method

5.1.1 First round of indicator revisions

Statistical analysis of the results was carried out on the basis of the obtained expert self-assessment forms, evaluation of the importance of the indicators, and modifications made by the experts.

In general, the degree of expert authority is greater than or equal to 0.7, which indicates that the results have a certain degree of authority, and the results of this survey show that the mean value of the overall authority coefficient is 0.73, which indicates that the results have a certain degree of authority. If the mean value of the importance of all indicators is greater than 4.2 and the frequency of the full score is greater than 0.3, then it indicates that the degree of concentration of the indicator system is high. In general, when the coefficient of variation is greater than or equal to 0.25, it means that there is a big difference in the evaluation of an indicator by experts, and the consistency is low. In this case, the indicator needs to be modified or deleted to improve the consensus among experts. According to the analysis of the results of this survey, it can be seen that the coefficient of variation of all indicators is less than 0.22, which indicates that the degree of coordination of the indicator system is good.

5.1.2 Second round of indicator revisions

The questionnaire was designed according to the revised indicator system in the first round and sent to 12 experts who participated in the first round, and 12 valid questionnaires were collected. The results were then analyzed based on the expert information, the expert self-assessment form, and the evaluation of the importance of the indicators returned in the second round.

(1) Expert information results analysis

The 12 experts were analyzed in terms of years of experience, workplace, nature of the workplace, and job title. The results of the research showed that all the participating experts were from higher education institutions. In terms of title distribution, there were three experts with full senior titles, three experts with associate senior titles, two experts with intermediate titles, and four experts with junior titles. In terms of working experience, the average working experience of the experts was 11.1 years, among which the number of experts with more than 20 years of working experience was six. According to the analysis results, the experts who participated in this research not only have a high level of professional knowledge, but also have rich working experience in related fields. This indicates that the results of the research have a high level of professional authority and can ensure the reliability and validity of the research to a large extent.

(2) Analysis of expert self-assessment forms

After assigning corresponding values to the judgment basis and familiarity in the expert self-assessment table provided by the 12 experts, an analysis was conducted to derive the degree of authority of the experts. The results show that there are 8 experts with authority coefficients greater than 0.7, and the average value of the overall authority coefficient is 0.76, so it can be concluded that the results have a certain degree of authority.

(3) Analysis of the results of the scoring of the level of importance of indicators

By analyzing the scoring evaluation of the 12 experts, it is found that the mean value of the importance of all the indicators is greater than 3.5, and the frequency of full scores is still good, which shows that the degree of concentration of the indicator system is high. The coefficient of variation of all indicators is less than 0.25, and the standard deviation is less than 0.9, which shows that the degree of coordination of the indicator system is good. Summarizing these analyses, it can be seen that the experts have a high degree of agreement with the current indicator system and have not put forward suggestions for adjustment. Therefore, the current indicator system is reasonable, and there is no need for a third round of expert review.

5.2 DEMATEL-Based Analysis of Impact Results

5.2.1 Centrality analysis

By observing Table 4, it can be seen that the centrality of green building materials R&D A_{13} is 2.594, the centrality of R&D technology funding A_1 is 2.473, and the centrality of technology experience A_4 is 2.152, which are the three factors that occupy the main influence among all the factors, and greatly influence the other factors, and to a certain extent are influenced by the other factors. Among them, the factor of insufficient R&D of green building materials has the highest value of centrality among all the factors, which represents its highest degree of influence among all the influencing factors, and is also the focus of solving the problem of hindering this aspect of green farmhouse technology. In the construction of green farmhouses, firstly, due to the influence of regional climate, terrain, customs, etc., the construction of green farmhouses needs to use local green building materials, which leads to the diversified demand for green building materials. Afterwards, suitable green building materials largely affect the final presentation of the green farmhouse, and its presentation affects the investors' intention to invest in green farmhouse-related technologies. Finally, the abundance of funds for R&D of related technologies not only affects the R&D of related technologies, such as the development of green building materials, but also affects the promotion of related technologies, thus affecting the construction process of green farmhouses and the accumulation of experience in the construction of green farmhouses, which has a series of impacts on other factors. Therefore, to a certain extent, the R&D of green building materials occupies a certain position in the technical aspects of green farm houses.

5.2.2 Causality analysis

By observing Table 4, it can be seen that there are six cause factors and nine effect factors in the influence factors hindering the green farmhouse technology. Among them, the reason degree value of the three influencing factors of farmer income, building materials R&D, and R&D technology funds is the highest among all factors, which means that the other factors are most affected by these three factors, and also means that these three factors are the key factors hindering the technology of green farmhouse, therefore, if we want to make the application of the relevant technology of green farmhouse more smoothly, we need to start with these three factors first.

5.3 ISM-Based Hierarchical Characterization of Factors Impeding Green Farmhouse Technology

As can be seen from Figure 1, the hindering factors of green farmhouse technology can be categorized into six layers in the explanatory structural model, and at the same time, according to the degree of influence of each factor, it can be further categorized into superficial, intermediate, and deep factors. Among them, the first layer is the surface layer factors, that is, it has less influence on the other factors and is greatly affected by the other factors, and is the result of the common influence of the other factors. Therefore, to enhance the level of technical personnel, accumulation of technical experience and other direct intervention in the surface layer of the factors can promote the development and application of green farmhouse technology, but to make it really play an impact, one must also rely on the second layer of intermediate factors playing a role, that is, the need to enhance the second level in the influence of the factors in the surface layer of the factors can be made more effective.

Intermediate factors are the second to fifth tier of influencing factors. As an intermediate factor, its internal layers interact with each other, the relationship is intricate, so the problems derived from it sometimes involve a variety of factors, or a number of problems will involve the same factor, that is, the whole body should be more comprehensive in the consideration of such issues; in the external structure of the upper and lower, while assuming the role of transmission, the impact of the deeper factors indirectly to the surface layer of the factors, so as to produce a more extensive impact.

The deeper factor is the sixth factor, i.e., farmers' income, which is the fundamental influence that hinders the development of green farmhouse technology and is not influenced by any other factors, so it plays a decisive role in the whole structure. By optimizing it accordingly, it can influence the intermediate factors, and then indirectly influence the surface factors, so as to positively promote the whole structure. Farmers' income, as the economic basis for affecting farmers' investment in green farmhouse construction, determines whether the level of farmers can generate demand for the application of green farmhouse technology, thus affecting the obstruction of green farmhouse technology. It can be seen that the level of farmers' low income is a key factor hindering the development of green farmhouse technology.

5.4 Attribute Analysis of Factors Hindering Green Farmhouse Technology Based on MICMAC

According to Figure 2, it can be seen that the dependent factor group contains technicians, suitable building materials, construction technology R&D, water treatment system R&D, the factor dependence value of this quadrant is high, and the driving force value is lower, which indicates that this quadrant factor is more influenced by other factors, but has less influence on other factors; the autonomous factor group contains the channel of funding for agricultural housing, suitable construction technology, suitable water treatment technology, suitable energy-saving technology, green technology effect, the quadrant's factor dependence value and driving force value are low, indicating that the quadrant's factors have less influence on other factors, and other factors have less influence on them; the related factor group contains R&D technology funds, technology experience, building materials R&D, building materials market, and the quadrant's factor dependence value and driving force value are both high, indicating that the quadrant's factors are more active, i.e., they have more influence on and affected by other factors; the independent factor group contains farmers' income, building materials R&D, building materials market, the quadrant factors have higher driving force value and lower dependence value, which indicates that the quadrant factors affect other factors more and are less influenced by other factors.

5.5 Joint Verification (JV)

According to the influence hierarchy in the explanatory structure model, it can be roughly divided into three factor groups, which are the deep level, i.e., the budget funding factor group, the middle level, i.e., the green farmhouse technology R&D factor group, and the surface level, i.e., the green farmhouse technology promotion and technology selection factor group; the driving and dependence of the influencing factors in the MICMAC model was analyzed, and was classified into four factor groups based on the results, i.e., dependence, correlation, autonomy, and independent factor clusters. The results of the two were cross-validated and analyzed to explore the relationship between the influencing factors, and the results of the analysis are as follows:

First, a cluster of budgetary funding factors for green farmhouse technology.

Farmers' income, which is the main determinant of the budgetary resources for farm buildings, is the basis for influencing the technology of green farm buildings, and it is in the group of independent factors. The construction of green farmhouses is linked to the needs of farmers, and the income level of farmers also has a certain impact on the selection of relevant technologies. Therefore, the income level of farmers will greatly affect their willingness to build a green farmhouse, and at the same time they also need to consider the local environment and other aspects of the limitations, so the farmers' income to a certain extent will depend on the construction of agricultural housing funds and related technology selection and other financial channels to have a certain impact. At the same time, the limitations of farmers' income will affect the construction effect of green farmhouse, which will have a direct or indirect impact on the green farmhouse technology R&D funds, such as construction technology and other related technology R&D. It can be seen that the results of the ISM and MICMAC models are mutually verified, and the budget funding factor group itself is in a higher order position, which has direct or indirect influence on other factors and is less affected by other factors.

Second, green farmhouse technology development and effect factor clusters.

Seven factors, such as R&D technology funding, construction technology R&D, and energy-saving technology R&D, are important influencing factors for green farmhouse technology and play a role in obstructing its development. Among these, energy-saving technology R&D is considered an independent factor. Energy-saving technology R&D is a crucial component of technological advancement, as the quality of this technology directly affects the energy-saving effectiveness of green farmhouses. Superior energy-saving technology can promote the advancement of other technologies and research areas; conversely, inadequate energy-saving technology can hinder the development of related technologies and slow the promotion process of green farmhouses. Thus, the strengths and weaknesses of energy-saving technology impact the R&D of green farmhouse technologies, such as building materials, water treatment technologies, and the promotion of associated technologies. Although energy-saving technology R&D is less affected by other factors, it still influences green farmhouse technology and is impacted by deeper underlying factors. The three factors of R&D technology funds, the building materials market, and building materials R&D are classified as related factors. Effective investment in and R&D of these three factors can further influence the selection of appropriate green farmhouse technologies, such as water treatment technology and building materials technology, and the promotion of these related technologies. However, these factors are still influenced by the level of farmers' income. The two factors of green technology effectiveness and financial channels for farm buildings are relatively unique autonomous factors; their influence on other factors and vice versa is minimal. However, despite being autonomous factors, their dependence and driving force values are still relatively high, indicating that they are still influenced by and have an influence on other factors. The advantages and disadvantages of the building materials market affect the use of green technology to some extent, and its specific performance may impact investor decisions, subsequently affecting R&D funding and technology development. These factors are indirectly influenced by the deeper factor of farmers' income. Furthermore, the level of farmers' income affects whether local banks and other financial institutions issue relevant credit and financial products and the variety of such products. Therefore, farmers' income has a certain impact on the financial channels for agricultural housing. This illustrates that the above factors not only affect surface-level aspects but are also influenced by deeper factors, such as farmers' income, within the group of related factors.

Third, green farmhouse technology promotion and technology selection factor groups.

In the ISM, technical experience, technicians, appropriate construction technology, and other seven influencing factors located in the top layer of the model can directly affect the green farmhouse technology, in which technicians, appropriate building materials, and water treatment system R&D are in the MICMAC model in the group of dependent factors. These three factors are an important part of green farmhouse technology in the construction of farmhouses; technicians are the basis for guaranteeing the effective construction of green farmhouses; and suitable building materials and water treatment system R&D are the important factors affecting whether green farmhouses can really play their green characteristics. At the same time, these three factors are also affected by farmers' income, related technology development, and other factors. In addition, the three factors of appropriate construction technology, appropriate water treatment technology, and appropriate energy-saving technology are autonomous factors that will directly affect the green farmhouse technology. Although the selection of appropriate technology for construction technology, water treatment technology, and energy-saving technology is affected by technology R&D and farmers' income, it is restricted by the local environment more prominently, so it is relatively independent. Technical experience is a relatively special correlation factor, which is affected by technology R&D and farmers' income and also affects technicians and suitable building materials, etc. The results of the ISM model and the MICMAC model have been further verified with each other, which makes the relationship between the influencing factors clearer and the hierarchical relationship also clearer.

6 Conclusions and Recommendations

6.1 Findings

Through the combination of DEMATEL-ISM-MICMAC three methods of analysis, DEMATEL results analysis concluded that green building materials R&D, R&D technology funds, technical experience of these three factors have a greater impact, occupying the core position need to pay attention to. It also identifies six cause factors such as farmers' income, building materials R&D, R&D technology funds, and nine result factors such as suitable building materials, water treatment system R&D, and so on.

The ISM-MICMAC results were analyzed to identify three factor groups of impediments to green farmhouse technology, namely, the budgetary resources factor group, the green farmhouse technology R&D and effectiveness factor group, and the green farmhouse technology promotion and technology selection factor group. Among them, the budgetary capital factor group, i.e., farmers' income, plays a fundamental role in the obstacles to green farmhouse technology, has a direct or indirect effect on the other factors in the model, and is basically unaffected by them. Green farmhouse technology R&D, and the effect of the factor group is specifically divided into technology R&D, the use of the effect of building materials, and three parts. These three parts of the development process will be affected by the impact of funds, so the impact of the budget funds factor group, such as the limitations of the level of farmers' income, will affect the building materials market in the market atmosphere that may lead to building materials of good and bad quality, thus affecting the use of the effect of the green farmhouse technology, which will strike the relevant technology R&D of enterprises. These three will have a direct impact on the origin of the application of technology in the construction of green farm buildings, which is the core element that affects the obstruction of green farm building technology. Green farmhouse technology promotion and technology selection factor groups, including technical experience, technical personnel, appropriate construction technology, etc., are the surface factors affecting the obstruction of green farmhouse technology, and they directly affect the actual application of green farmhouse technology. However, a large part of technology promotion and technology selection is affected by technology development, use effect, and building materials, and therefore is affected by the green farmhouse technology development and effect factor group. Therefore, if we want to improve the obstacles of green farmhouse technology, we need to start from the budget funds and technology R&D and effect, and implement the use of technology in the actual construction of green farmhouse so as to improve it.

This study explores the hindering factors of green farmhouse technology and, at the same time, utilizes DEMATEL-ISM-MICMAC three methods for combined analysis to effectively make up for the shortcomings of the three, adequately shows the relationship between the hindering factors of green farmhouse technology more concretely, and provides a clearer path for the promotion and use of green farmhouse technology. Although our study provides a clearer path for the development of green farmhouse technology, there are still some limitations.

Firstly, due to the use of the expert scoring method, it makes the resultant data somewhat subjective. Secondly, this study mainly researches from the aspects of funding, technology promotion, R&D, etc., less considering the policy, farmers' subjective willingness, regional limitations, and the influence of enterprises on the green farmhouse technology, so there will be a lack of data in the presentation. In future research, more diversified methods such as fsQCA (Fuzzy-set Qualitative Comparative Analysis) can be used to classify the importance of the factors affecting the local obstacles to green farmhouse construction technology according to the actual situation in different regions, so as to provide more accurate suggestions.

6.2 Suggestion

1) Improving farmers' incomes and broadening access to farm housing finance

Relevant policies have been formulated to promote the development of the rural economy in various ways, such as promoting the diversification of rural industries and the development of local specialties in agriculture and rural tourism, so as to increase farmers' sources of income. At the same time, local governments, in conjunction with relevant financial institutions, have established a sound rural financial service system, providing farmers with housing loans and financial subsidies to encourage and support the construction of green farm buildings.

2) Regulate the building materials market and develop a sound system for assessing building materials

Developing and promoting green building materials standards and establishing a green building materials certification system to ensure that all relevant products meet environmental and quality requirements. Developing a market access system for building materials, strictly controlling enterprises in the market so that only those that meet the standards can enter the market, and at the same time strengthening market supervision, combating counterfeit and shoddy products, and maintaining market order.

3) Strengthening technology R&D and promoting the use of technology

Formulate relevant policies, increase investment in technology R&D, and encourage and support enterprises in R&D and innovation. Establish a green farmhouse technology R&D center to promote the combination of industry, academia and research, and dispatch relevant technicians to rural areas to promote technology and learning, so as to improve the level of local construction technology.

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Data Availability

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

Conflicts of Interest

The authors declare no conflict of interest.

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