



Obstacles and countermeasures for promoting prefabricated housing in rural areas of Jiangsu, China

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Abstract

Prefabricated housing (PH) is widely supported and applied in China due to its high efficiency and low carbon emissions. However, the adoption of this sustainable construction method has been slow in rural areas, hindered by economic, policy and location factors. To promote the development of low-carbon construction in rural areas and address the obstacles, this study focuses on Jiangsu province as a case study, proposing effective strategies to modernize and advance sustainable rural housing. The primary barrier to the prefabricated concrete (PC) adoption in rural Jiangsu were identified through a literature review and expert interviews. A survey was then conducted to assess the impact of these barriers, yielding 228 valid responses from industry professionals. Factor analysis was conducted using SPSS 19.0 to calculate the multi-level weights for influencing factors across dimensions. Based on these findings, key obstacles were further analyzed through strengths, weaknesses, opportunities and threats analysis to develop targeted countermeasures and recommendations. The research results show that: (1) Among secondary indicators, Policy factors (weight = 0.219) and Location factors (weight = 0.215) have the most significant impact PC promotion in rural Jiangsu; (2) Among the tertiary indicators, the critical factors are "The standard system is incomplete" (weight = 0.059), "The technical system is not mature" (weight = 0.048), "Lack of specific departments for promoting and supervising at the grassroots level" (weight = 0.046); (3) Strategies such as enhancing policy alignment and market penetration, tailoring solutions to local demands, establishing a robust regulatory framework, and fostering community engagement and acceptance can effectively address the challenges of promoting PC in rural areas. This research provides actionable pathways for the advancing PH in Jiangsu and offers valuable references for other regions seeking to promote PH in China.

Keywords: Prefabricated housing, Jiangsu rural areas, obstacle factors, promotion strategies

1. Introduction

With China's rapid economic growth, traditional building methods, especially in densely populated urban centers and rural or remote areas, are no longer sufficient to meet the demands of residential housing, resource conservation and, environmental protection^[1]. Prefabricated housing (PH) offers advantages in resources and energy savings, reducing construction pollution, and improving labor productivity, quality, and safety^[2-4]. Additionally, the increasing demand for higher-quality housing and the growing emphasis on green and low-carbon living have accelerated the development of PH within China's construction sector^[5]. Prefabrication, or off-site construction, presents substantial opportunities for enhancing both environmental and economic performance, making it an increasingly attractive alternative to traditional on-site construction^[6].

Prefabricated rural housing typically consists of three-story or smaller houses assembled on rural homesteads. Figure 1 shows the three common structures of prefabricated rural houses, including prefabricated concrete (PC) structure, prefabricated steel structure, and prefabricated wood structure, each with distinct advantages and disadvantages. PC structures have a short construction period but involve heavy components and higher cost; light steel structures are easier to transport and install but have lower fire resistance;



prefabricated wood structures have good thermal insulation but are costly and face a shortage of skilled professional. In the construction industry, the application of prefabrication methods has progressively matured^[7]. As a modern construction approach, PH is valued for its multiple advantages^[8]. These include high energy efficiency, environmental benefits, labor savings, and rapid construction speed, all of which align with the sustainable development goals of the construction industry^[9,10]. Cao *et al.* conducted a comparative study on two residential projects in China^[2], one using prefabrication technology and the other using traditional cast-in-place methods. The study found that prefabrication significantly reduces environmental impacts, such as resource depletion, energy consumption, and construction waste generation. PH represents a significant shift towards sustainable building practices and offers numerous advantages over traditional construction methods^[11]. This is particularly relevant in rural areas, where conventional building techniques often fail to meet the demand for efficient and eco-friendly structures^[12]. In addition, studies have found that prefabricated homes can reduce worker mobility and alleviate traffic problems compared to traditional construction models^[3]. It shows that prefabricated buildings can address some of the construction challenges in rural areas. In summary, the need to reduce construction, maintenance, and operational costs, while ensuring flexibility to adapt and expand residential units has become essential. The spatial patterns, structures, and social organization of the countryside have changed dramatically in the process of rapid industrialization and urbanization, and many rural areas can no longer withstand these challenges^[13]. Meanwhile, energy consumption in rural areas is characterized by being extensive and decentralized, and it is one of the important sources of greenhouse gas emissions. Strengthening the construction of clean energy in rural areas and accelerating the transformation of prefabricated buildings for rural residences can effectively promote the achievement of the “dual-carbon” goals^[14,15]. The transformed and restructured of China’s rural areas contribute to achieving rural revitalization and integrated urban-rural development^[16]. Promoting PH in rural areas is an important step toward this “Beautiful Village” initiative. Therefore, implementing PH in rural areas necessitates the development of targeted strategies that address the unique challenges and opportunities of promoting PH in rural contexts.

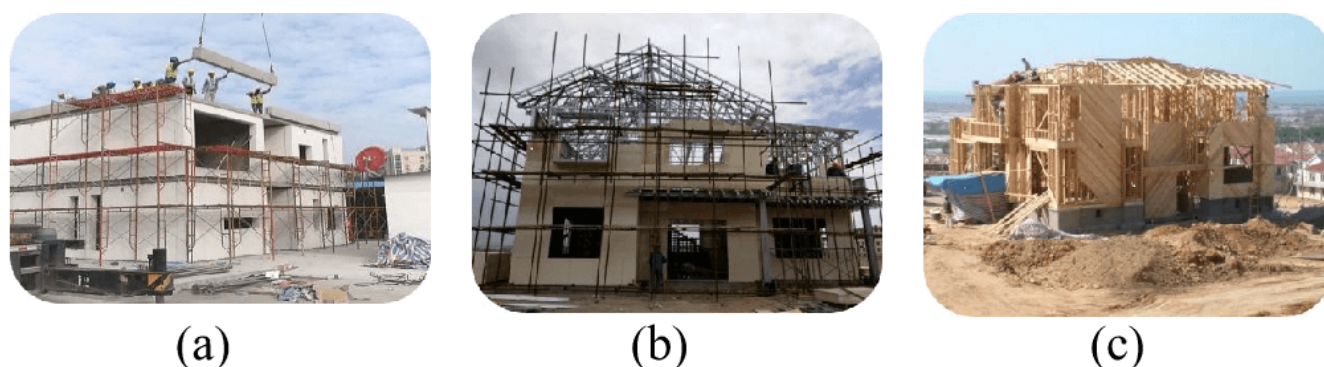


Figure 1. Three common structures of prefabricated rural housing. (a) Prefabricated concrete structure; (b) Prefabricated steel structure; (c) Prefabricated wood structure.

Jiangsu province, located along the eastern coast of China, holds country’s significant economic and cultural influence in the country. Jiangsu primarily experiences meteorological disasters, including floods, rainstorms, droughts, typhoons, with occasional tornadoes affecting certain areas. Economically, Jiangsu benefits from a strategic location and a high level of development. Concurrently, Jiangsu Province, a pivotal region in China’s pursuit of PH development, has launched substantial initiatives to integrate PH into its construction framework. As of 2023, newly developed PH in Jiangsu covers approximately 250 million square meters, marking a notable escalation in the proportion of PH in new constructions, from 3% in 2015 to 41.0% in 2023^[17]. However, some areas face challenges in their industrial structure. For example, the employment proportion of the tertiary industry in some rural areas remains low, and there is a noticeable gap between urban and rural development. Promoting prefabricated buildings in rural areas of Jiangsu Province is reasonable, feasible, and necessary. The rationale lies in that it can adapt to the natural characteristics and settlement forms of different regions in Jiangsu, and an appropriate PH structure type can be selected according to the actual situation. Feasibility is supported by factory production of prefabricated components, which ensures quality and precision, and by the maturing technical system, allowing Jiangsu to benefit from advanced domestic and international experiences. The necessity arises from the fact that traditional rural houses are gradually falling behind in terms of construction technology. Prefabricated buildings, on the other hand, can shorten the construction period, be more environmentally friendly, reduce potential safety hazards, and improve the quality and safety of rural housing. At the same time, with rural economic development and environmental improvement, prefabricated buildings can help promote the modernization of rural construction, narrow the urban-rural gap, and provide a more comfortable living environment for rural residents.

China places significant emphasis on the benefits of prefabricated buildings and has developed a policy document outlining Quality Acceptance Standards for the Construction of Prefabricated Buildings^[18]. However, the present scenario of PH development in China underscores a striking disparity between urban and rural domains. Specifically, the urban residential PH market occupies a commanding position, whereas the progress of PH in rural areas lags significantly behind. In 2023, adhering to the principles of rural

revitalization policies, the Ministry of Agriculture and Rural Affairs of China formulated the “Rural Revitalization Standardization Action Plan”, with the objective of establishing benchmarks for enhancing rural housing conditions and infrastructure development^[19]. National policy support underscores the importance of advancing PH in rural areas, yet high initial costs and limited incentives hinder progress, leaving China’s PH development behind that of other regions and developed countries^[20]. Addressing these challenges requires a comprehensive approach that includes technological advancements, economic incentives, social acceptance, policy reforms, and improved management strategies.

Existing academic research presents various perspectives on the barriers to advancing PH. Wu *et al.* analyze the factors affecting the promotion of PH from a stakeholder perspective^[21]. Zhong *et al.* conducted a comprehensive evaluation of China’s prefabricated construction costs using the hierarchical analysis method and concluded that the incremental cost of prefabricated components outweighs the reduction in labor costs^[22]. Using a cost-benefit analysis, Shen *et al.* concluded that cost is the most significant barrier to the development of prefabricated public housing from a developer’s perspective^[3]. Dave *et al.* identified reluctance or lack of awareness among builders and designers, financial industry/bank policies, societal perception issues, the risk of adapting to new processes and systems, and insufficient investment in the industry for research and development as the biggest constraints to the adoption of prefabrication^[6]. Shi *et al.* developed an evaluation model containing 16 indicators across four dimensions-political, economic, social, and technical-to evaluate the potential for implementing rural prefabricated components^[23]. Key technological barriers include immature critical technologies and low standardization and integration of prefabricated components^[9,24]. Social acceptance, public awareness, and a shortage of skilled professionals are also critical^[10,25]. Policy issues, such as inadequate industry standards and regulations, and management challenges, like immature operational models, exacerbate the complexity^[11]. These challenges reflect the current situation in China, where technological difficulties restrict the application of PH in high-rise structures. Additionally, low market recognition reduces companies’ enthusiasm for promotion, revealing how market forces significantly impact PH development. Recognizing and managing these obstacles is crucial for the successful promotion and broader application of PH in China. Despite differing conclusions across studies, they converge on similar themes, particularly emphasizing the importance of cost-related issues, policy frameworks, and market dynamics. Additionally, Jiangsu Province, as a leading force in China’s construction industry, has implemented proactive policies to stimulate the growth of PH and foster related enterprises. However, there remains a significant gap between urban and rural advocacy efforts. Current policy interventions are heavily skewed towards the urban housing market, with relatively less support for the rural market. Moreover, stricter national environmental regulations and rising costs of traditional building materials pose significant challenges for adopting prefabricated technologies in rural areas. These include logistical issues such as transportation and installation, cost management pressures, compliance with fire safety requirements, and insufficient market familiarity with prefabricated construction obstacles.

In summary, promoting PH in rural areas is important, yet it also poses challenges. Despite extensive literature on the promotion of PH in rural areas, there is a lack of consensus, systematic methods, and effective recommendations regarding the factors hindering the adoption of prefabricated buildings and their significance. Most existing literature research objects select a particular aspect of the obstacle factors. Wu, Zhong, Shen, and others analyze these barriers from the cost perspective^[3,21,22], Wang and Wu analyzed them from a technical standpoint^[9,24], and Michael analyzed them from the policy perspective^[11], but there is a lack of comprehensive analysis of all factors. This paper sorts out obstacles in various categories based on previous studies. In terms of methodologies, Shen and others used cost-benefit analysis^[3], and Zhong and others used the analytic hierarchy process to calculate weights^[22]. However, these two methods are not suitable for researching the barriers to promoting rural PH. Cost-benefit analysis mainly focuses on the economic input-output and lacks consideration of non-economic factors. For instance, it does not capture the cultural acceptance and social recognition of rural residents towards prefabricated houses. Similarly, while the analytic hierarchy process determines the factor weights, it often relies on the subjective judgment of experts, which can introduce subjectivity and limitations.

Therefore, this study employs the factor analysis method, which, with a larger sample size, yields more scientifically robust results. Given Jiangsu province’s crucial role in the development of prefabricated construction in China, the conclusions drawn from the research on rural areas in Jiangsu province can be widely applicable and serve as a foundation for policy development in other regions. This paper systematically identifies the obstacles to promoting PH in Jiangsu’s rural areas through a combination of literature review and expert interviews. Data were collected using a questionnaire survey and analyzed through descriptive statistics, reliability analysis, and factor analysis. The study identifies the key factors hindering the promotion of PH in rural Jiangsu and ranks them across five dimensions. Based on the research findings, the strengths, weaknesses, opportunities and threats (SWOT) method is employed to propose strategies for the promotion of PH in rural Jiangsu, aiming to support the sustainable development of rural PH. This research aims to provide valuable references for policymakers, industry stakeholders, and academics, facilitating the broader adoption of PH in rural areas. Additionally, research findings and policy insights from Chinese can help guide the development of targeted policies in other countries facing similar challenges.

2. Methodology

2.1 Research framework

To investigate the key obstacles affecting the promotion of PH in rural areas of Jiangsu province and propose effective

countermeasures, a research framework is outlined in Figure 2. The methods employed include literature review, field and online interviews, factor analysis, and SWOT analysis. These methods and the associated research framework have been well established and validated in previous studies^[26,27]. Specifically, the research organizes, categorizes, and synthesizes the constraints identified in 21 Chinese journal articles and interviews regarding the promotion of PH. The obstacles are classified into five dimensions: policy, market, technology, location, and management, creating a comprehensive set of indicators for each dimension. Based on these promotional obstacle indicators, a questionnaire is designed and distributed to collect perceptions regarding expectations and obstacles related to the promotion of PH in rural areas. SPSS 19.0 is then used to conduct sample analysis, along with the reliability and validity analysis of the questionnaires. Subsequently, factor analysis is used to calculate the weight of each factor and rank the weights to identify the main obstacles. Finally, a SWOT matrix is constructed to provide recommendations and references for advancing PH in rural Jiangsu.

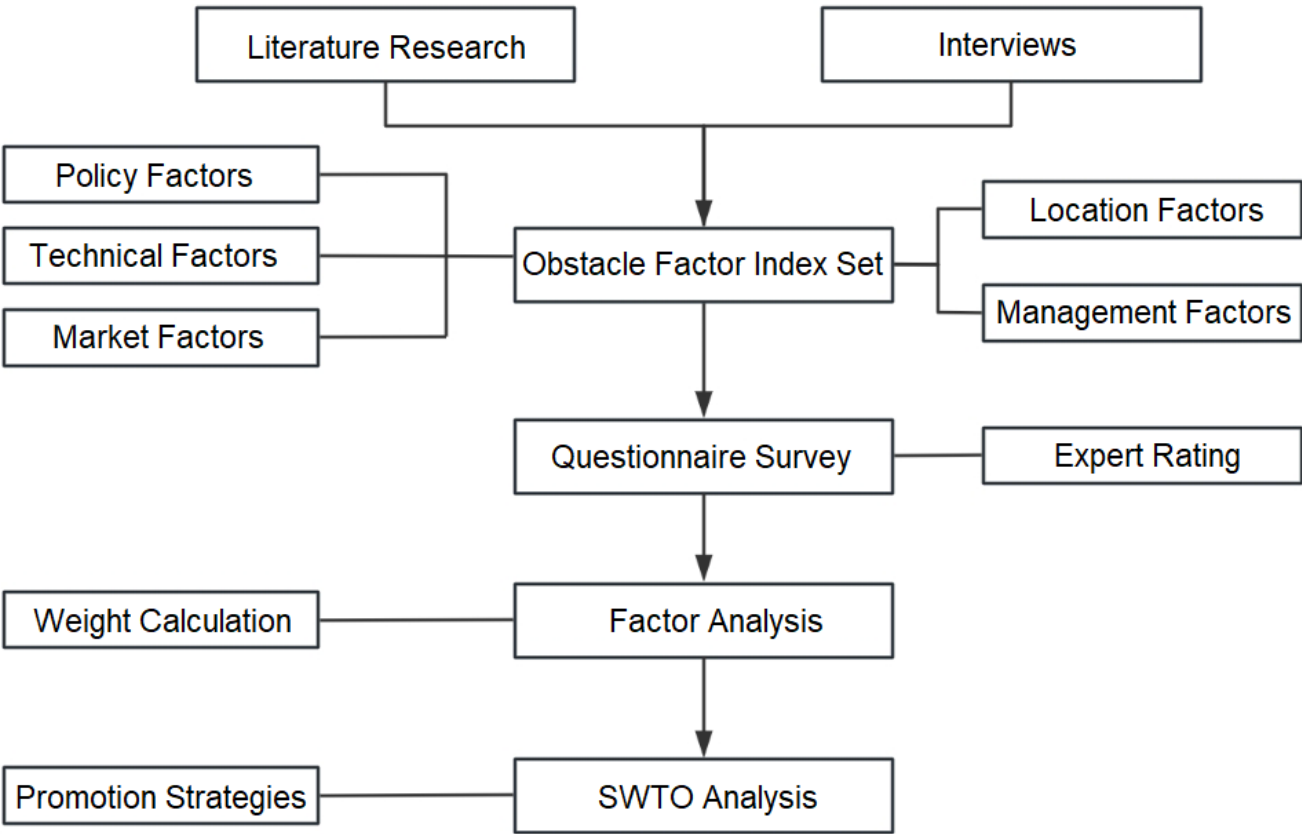


Figure 2. Technical Framework. SWOT: strengths, weaknesses, opportunities and threats.

2.2 Literature research and interviews

In previous studies, qualitative scientometrics analysis was used to identify the variables or factors of the study^[28]. The literature review involves a thorough examination and systematic organization of relevant sources, aiming to identify and summarize the primary obstacles encountered by rural areas in advancing PH. Given the scarcity of research specifically focused on promoting PH in rural regions, this study also examines factors that may hinder the implementation of PH in these areas, considering the broader context of constraints affecting prefabricated construction development. A search of domestic electronic literature databases yielded 21 pertinent articles. The obstacles identified in these articles were summarized and coded, resulting in the identification of 33 distinct obstacles.

Interviewing, as a qualitative research method, can validate the identified factors, confirming their ongoing relevance and significance^[29]. Building on the literature review, interviews provide a deeper understanding of the obstacles to promoting PH in rural areas. This study included both field and online interviews with relevant enterprises engaged in the research, development, production, and promotion of rural PH, as well as with some rural residents. The objective was to identify the primary challenges faced by enterprises in market promotion and to gain insight into villagers' perceptions and awareness of PH. The results from the interviews further corroborated the obstacles identified in the literature review. Specifically, interviewees emphasized four key obstacles: the influence of traditional beliefs among rural residents, the lack of skilled professionals in the engineering field, the absence of standards for rural PH, and the relatively high market price of PH. These findings indicate that these factors pose

substantial challenges to the practical promotion of PH. Notably, no new obstacle factors emerged during the interviews, which validates the comprehensiveness and reliability of the literature review, indicating that previous studies adequately addressed the major issue areas.

A comprehensive set of indicators related to the obstacles hindering the promotion of PH in rural areas is presented below.

2.3 Questionnaire survey

In management research, surveys are a commonly used data collection method. By incorporating high-quality questionnaires, the quality of the research data can be effectively controlled^[30]. The questionnaire used in this study was independently developed in collaboration with experts specializing in prefabricated building research. It consists of three sections: background information about the respondents, an assessment of the influence of various factors, and attitudes and attitudes regarding rural PH.

The first section gathers information on respondents' gender, age, educational background, years of experience, job title, organization type, and type of PH they are familiar with. The second section assesses the degree of impact of obstacle factors identified through literature reviews and expert interviews. This assessment is based on respondents' perceptions, using a five-point Likert scale, ranging from no impact (1 point) to very significant impact (5 points). The third section, informed by previous field and online interviews, consists of five questions designed to gauge respondents' attitudes toward the promotion of PH in rural areas of Jiangsu province, specifically including: 1) How do you view the prospects of promoting PH in rural Jiangsu? 2) Are there any related enterprises around you that are engaged in the promotion of rural PH? 3) Are you willing to expand rural PH related businesses or engage in related work? 4) How long do you expect it will take for PH to become the mainstream in the rural housing market? and 5) Which type of prefabricated structure do you think is more suitable for promotion in rural areas of Jiangsu? Before formal distribution, experts in prefabricated construction were invited to conduct a pilot test to address issues related to wording and comprehension. The questionnaire was further modified based on their feedback to ensure its validity and accuracy.

The survey was primarily conducted within Jiangsu province, targeting individuals involved in the PH industry. This includes staff from governmental departments promoting prefabricated construction, researchers from universities and research institutions, and professionals engaged in the research, design, production, sales, construction, and transportation of PH. The questionnaire was distributed both online and offline to balance convenience and coverage. A total of 312 questionnaires were collected, and after excluding invalid and incomplete responses, 228 valid samples remained, yielding a response rate of 73.1%.

2.4 Factor analysis

Factor analysis is a multivariate data analysis technique suitable for analyzing the relative importance of influencing factors^[31]. Factor analysis is a statistical technique used to identify a small number of common factors that can explain the majority of the variance in a set of observed variables. The fundamental concept of factor analysis is to express variables as linear combinations of a few common factors and specific factors, thereby achieving a reasonable explanation of the correlation among variables and aiding in variable selection^[32]. Integrating the definition of factor analysis with existing literature^[33], the basic model of factor analysis can be expressed as follows:

Given variables X_i (where $i = 1, 2, \dots, n$), these n variables can be represented as the product of a factor loading matrix A (of dimension $n \times m$) and m common factors F_m ($f_1, f_2, \dots, f_m$), plus a unique factor ε_p (where $p = 1, 2, \dots, n$) (with $n \geq m$):

$$X_i = a_{i1}f_1 + \dots + a_{im}f_m + \varepsilon_p \quad (2-1)$$

$$\begin{pmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & & & a_{2m} \\ \vdots & & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nm} \end{pmatrix} \begin{pmatrix} f_1 \\ f_2 \\ \vdots \\ f_m \end{pmatrix} + \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{pmatrix} \quad (2-2)$$

The steps of factor analysis include data preprocessing (such as missing value handling, outlier detection, and standardization), factor extraction (e.g., principal component method, determining the number of factors based on the principle of eigenvalues greater than 1), factor rotation (e.g., Varimax orthogonal rotation, optimizing the clarity and interpretability of factor loading structures), interpretation of factor loadings (identifying the contribution of each variable to each factor), and calculation of factor scores (converting original data into factor scores for subsequent analysis). Factor scores can be converted into weights for obstacle factors, with the magnitude of the weights reflecting the importance of each factor (i.e., key obstacle factors) in the overall impact of promotion obstacles^[34].

In determining the weights of indicators, the focus is on the weights of secondary indicators on primary indicators, the weights of tertiary indicators on secondary indicators, and the weights of tertiary indicators on primary indicators^[35]. Based on the factor score coefficient matrix, linear regression equations can be established for each principal factor and the variables it encompasses. The

factor score coefficients reflect the degree of influence of independent variables on dependent variables. Therefore, by normalizing the factor score coefficients, the weight values of each independent variable on its principal factor can be obtained. The weight of tertiary indicators on primary indicators can be determined by the product of the weights of secondary indicators on primary indicators and the weights of the included secondary indicators on the principal factor. Important data in the factor analysis process include the contribution rate of the principal factors and the factor score coefficient matrix.

2.5 SWOT analysis

SWOT analysis is a strategic tool commonly used to comprehensively evaluate a company’s strengths, weaknesses, external threats, and opportunities^[36,37]. It serves as a basis for developing, evaluating, and selecting strategic plans for enterprises. The SWOT analysis typically follows a three-step process. First, detailed investigations are conducted to gather information on opportunities, threats, strengths, and weaknesses. This involves utilizing research methods to analyze the external environment and internal conditions of the enterprise. Second, the collected data is organized and categorized, with each factor listed in a tabular format. The factors are ranked according to their level of influence, prioritizing the most urgent and significant factors at the forefront, followed by those deemed less important or with a weaker impact. Finally, a matching analysis is conducted within the SWOT matrix to develop practical strategic plans.

3. Results

3.1 Obstacle factor index set

Following the literature review and interviews, all identified obstacle factors were coded, consolidated, and categorized. Based on this analysis, an obstacle factor index set for promoting PH in rural areas of Jiangsu was constructed, comprising 29 obstacle factors as shown in Table 1. The identified obstacles were categorized and systematized based on their nature and relevance to the rural environment in Jiangsu province. This process resulted in a comprehensive set of indicators organized into five dimensions: policy, market, management, technology, and location. Subsequently, the finalized obstacle factors were classified according to their respective dimensions, ensuring a one-to-one correspondence between factors and dimensions. The preset dimensions and classification of obstacle factors were subject to further validation and analysis in the subsequent sections.

Table 1. Index set of obstacles in popularizing rural residential buildings in Jiangsu.

Factor dimension	Factors
Policy Factors	A ₁ The grass-roots governments are ineffective in implementing the PB policies proposed at the national level
	A ₂ Lack of specific policies to guide rural residents in building PH
	A ₃ The financing channels for rural residents to build houses are not smooth enough
	A ₄ The tax rate of prefabricated building component production enterprises is too high
	A ₅ The development goals of PB do not involve rural areas
	A ₆ The laws and regulations related to rural housing construction are not perfect enough
	A ₇ Imperfect incentive policies for prefabricated related enterprises
Market factors	B ₁ The market price of PH is relatively high
	B ₂ Insufficient promotion of prefabricated housing in rural areas
	B ₃ Relatively few relevant institutions are engaged in the research and development of PH in rural areas.
	B ₄ The research and development costs of rural prefabricated residential products are high and the returns are slow
	B ₅ The transportation cost of prefabricated residential components is relatively high
	B ₆ The rural PH industry chain is not sound and perfect enough
Management factors	C ₁ Lack of specific departments for promoting and supervising rural PH at the grassroots level
	C ₂ Lack of systematic safety management technical regulations for construction and installation
	C ₃ The management system of PB component production enterprises is outdated
	C ₄ Lack of professional personnel in the management of PH construction
	C ₅ The comprehensive quality of the production and installation workers for PB components is not high

Technical factors	D ₁ The technical system of rural PH is not mature
	D ₂ The standard system for rural PH is incomplete
	D ₃ Lack of diversification in product solutions for rural PH
	D ₄ Lack of universality between components of rural PH
Location factors	E ₁ Frequent summer tornadoes in the Jiangsu region
	E ₂ The seismic advantage of PH in the Jiangsu region is not obvious
	E ₃ Narrow internal roads in rural areas of Jiangsu make it difficult to transport components
	E ₄ Compared with urban areas, the economic development in rural areas of Jiangsu Province is insufficient.
	E ₅ The layout of rural residential buildings in Jiangsu is compact, and the working area is small, making it difficult to construct
	E ₆ The foundation of prefabricated industry in the Jiangsu region is weak
	E ₇ The concept of building houses among rural residents in Jiangsu has not yet changed

PB: prefabricated building; PH: prefabricated housing.

3.2 Sample analysis

Descriptive statistical analysis and reliability testing were conducted on 228 valid questionnaires using SPSS 19.0 software.

Descriptive statistics were performed on demographic variables, with results presented in Table 2. Analysis of these data uncovers that, within the sample population from the prefabricated construction industry, male professionals constitute a significant majority, amounting for 66.67%. Regarding educational backgrounds, individuals with Bachelor’s or Associate’s degrees constitute an overwhelming majority, reaching a striking 82.45%. A substantial majority of the respondents have been working in the field for five years or less, indicating a recent surge in the rapid development of prefabricated building technology. Regarding the occupational hierarchy, those holding intermediate or higher professional titles or serving as middle-to-upper level managers, comprise 79.55% of the sample, which underscores the profound understanding and specialized expertise prevalent among the interviewees. From an organizational standpoint, 71.05% of the respondent hail from enterprises directly involved in prefabrication-related activities, bringing practical work experiences and a deep comprehension of both the advantages and disadvantages inherent in prefab architecture. Regarding expectations for the development of PH, respondents were relatively optimistic about rural PH. Most respondents believe that within the next decade, PH will become the mainstream construction method in rural areas of Jiangsu, and they support the promotion of PC structures in these regions.

Table 2. Demographic information of respondents (n = 228).

Variable	Category	Numberof cases	Frequency (%)
Gender	Male	152	66.67
	Female	76	33.33
Age	25 years old and below	38	16.67
	26-35 years old	80	35.09
	36-45 years old	61	26.75
	46-55 years old	39	17.11
	56 years old and above	10	4.39
Education	Doctor	2	0.88
	Master	21	9.21
	Undergraduate course	105	46.05
	Specialist	83	36.40
	Vocational school education or below	17	7.46

Related workingexperience	≤ 3 years	53	23.25
	3-5 years	108	47.37
	5-7 years	47	20.61
	7-10 years	14	6.14
	> 10 years	6	2.63
Job title	Senior professional title/senior manager	55	24.12
	Intermediate professional title/middle-level manager	105	46.05
	Junior professional title/grassroots manager	45	19.74
	No professional title/ordinary employee	23	10.09
Affiliation	Government departments in the construction industry	25	10.96
	Universities or research institutions	26	11.40
	Prefabricated related enterprises	162	71.05
	Other	15	6.58

Reliability analysis revealed that Cronbach’s alpha coefficients for policy, market, management, technical, and location factors were 0.906, 0.885, 0.897, 0.855, and 0.914, respectively. All coefficients exceed the threshold of 0.7^[38], and no significant gains were observed after item deletion. Additionally, corrected-item total correlation values confirm strong correlations among dimensions. Therefore, the sample data demonstrate high reliability and internal consistency, supporting the appropriateness of using this dataset for further analysis.

3.3 Factor analysis

Before conducting factor analysis, it is essential to perform the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett’s test of sphericity on the survey data. The results of these tests on the 29 obstacles to promoting PH in rural areas indicate that the KMO statistic is 0.898, which exceeds the threshold of 0.5, suggesting a high level of sampling adequacy. Bartlett’s test of sphericity yields a *Chi-square* value of 4,932.474 with a *P*-value less than 0.05, meeting the prerequisites for factor analysis and thus validating the suitability of the data for this analysis.

Principal component analysis with Varimax rotation was applied to the 29 variables. Variables with eigenvalues greater than 1 were included in the principal components, resulting in the extraction of 5 factors as the main components of the original 29 variables. The cumulative variance explained by these 5 factors is 14.991%, 14.695%, 13.853%, 12.523%, and 12.393%, respectively. These factors cumulatively accounted for a variance explanation rate of 68.455%, indicating that most of the information contained within the items being effectively extracted. A comprehensive presentation of these findings is depicted in [Table 3](#).

Table 3. Total variance interpretation rate.

Factor number	characteristic root			Interpretation rate of variance after rotation		
	Characteristic root	Variance interpretation rate	Accumulated	Characteristic root	Variance interpretation rate	Accumulated
1	11.405	39.326	39.326	4.347	14.991	14.991
2	2.660	9.170	48.500	4.262	14.690	29.680
3	2.465	8.490	56.990	4.017	13.850	43.530
4	2.025	6.980	63.980	3.632	12.520	56.060
5	1.297	4.470	68.450	3.594	12.390	68.450

Using the Varimax rotation method, the factor loading matrix was rotated, which preserved the cumulative variance and did not affect the extraction of principal components but altered the loadings of variables on these components. The rotated factor loading matrix is presented in [Table 4](#). To provide a more precise representation of the relationships between the obstacle factors and the principal components, only factor loadings greater than 0.5 are shown in the table. It is evident from the table that all factors have

commonalities greater than 0.4, indicating that most of the information from the factors can be extracted.

Table 4. Factor load factor after rotation.

Question items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Commonality
A ₁	0.716					0.662
A ₂	0.656					0.695
A ₃	0.815					0.723
A ₄	0.755					0.610
A ₅	0.686					0.748
A ₆	0.710					0.663
A ₇	0.785					0.718
E ₁		0.556				0.557
E ₂		0.684				0.567
E ₃		0.661				0.729
E ₄		0.795				0.764
E ₅		0.705				0.766
E ₆		0.840				0.807
E ₇		0.753				0.781
B ₁			0.772			0.693
B ₂			0.677			0.690
B ₃			0.788			0.734
B ₄			0.719			0.641
B ₅			0.745			0.652
B ₆			0.764			0.653
D ₁				0.673		0.632
D ₂				0.775		0.776
D ₃				0.573		0.501
D ₄				0.556		0.482
C ₁					0.655	0.714
C ₂					0.772	0.690
C ₃					0.781	0.747
C ₄					0.753	0.753
C ₅					0.785	0.704

In summary, the commonality of all items surpassed 0.4, indicating that a substantial portion of item information could be extracted effectively. The KMO value of 0.898, higher than the recommended 0.6, alongside the rotated variance explained rates of 14.991%, 13.853%, 12.393%, 12.523%, and 14.695% for the preconceived five factors, culminating in a total rotated variance explanation rate of 68.455%, which is notably greater than 50%, suggests that the content of the items has been effectively extracted according to the initially defined five dimensions. Thus, the questionnaire demonstrates good structural validity with respect to the overall correspondence between factors and items.

3.4 Calculation of index weights

In the factor analysis of obstacles to promoting PH in rural areas, the cumulative contribution rate of the 5 principal factors is 68.455%, with individual contributions of 14.991%, 13.853%, 12.393%, 12.523%, and 14.695%. The weight value A_i of the secondary indicators on the primary indicators is normalized according to the contribution rates of the principal factors, as shown in Table 5.

Table 5. Levels of indicators and their weights across different tiers.

Primary Indicators	Secondary Indicators	Tertiary Indicators	A_i	a_{ij}	A_{ij}	ω_i
Obstacles to Promoting Prefabricated Housing in Rural Areas	Policy factors(Factor1)	A_1	0.219	0.230	0.160	0.035
		A_2		0.264	0.184	0.040
		A_3		0.151	0.105	0.023
		A_4		0.190	0.132	0.029
		A_5		0.205	0.143	0.031
		A_6		0.160	0.111	0.024
		A_7		0.238	0.166	0.036
	Location factor(Factor2)	E_1	0.215	0.131	0.087	0.019
		E_2		0.247	0.163	0.035
		E_3		0.311	0.206	0.044
		E_4		0.180	0.119	0.026
		E_5		0.273	0.180	0.039
		E_6		0.158	0.104	0.022
		E_7		0.213	0.141	0.030
	Market factors(Factor3)	B_1	0.202	0.271	0.189	0.038
		B_2		0.245	0.170	0.035
		B_3		0.246	0.171	0.035
		B_4		0.223	0.155	0.031
		B_5		0.240	0.167	0.034
		B_6		0.212	0.148	0.030
	Technical factors(Factor4)	D_1	0.183	0.254	0.265	0.048
		D_2		0.311	0.324	0.059
		D_3		0.207	0.216	0.039
		D_4		0.188	0.196	0.036
	Management factors(Factor5)	C_1	0.181	0.321	0.252	0.046
		C_2		0.164	0.129	0.023
		C_3		0.292	0.229	0.041
		C_4		0.299	0.235	0.042
		C_5		0.198	0.155	0.028

A_i : weight of secondary indicators within primary indicators; a_{ij} : score coefficient; A_{ij} : weight of tertiary indicators within secondary indicators; ω_i : weight of tertiary indicators within primary indicators.

Factor score coefficient matrices, which can be obtained during the factor analysis process, are used to express secondary indicators as linear combinations of the included tertiary indicators, with corresponding coefficient variables a_{ij} . Therefore, the weight values A_{ij}

of the tertiary indicators on the secondary indicators can be derived by normalizing the factor score coefficient matrix a_{ij} with the results presented in Table 5.

The weight values ω_i of the tertiary indicators on the primary indicators are obtained by multiplying the weight values A_{ij} of the secondary indicators on the primary indicators by the weight values A_i of the tertiary indicators on the secondary indicators, as shown in Table 5.

Based on Table 5, we can determine the relative influence and importance of the items within each dimension. Here's how the order of importance could be summarized:

(a) Policy factors > Location factors > Market factors > Technical factors > Management Factors;

(b) Policy factors: $A_2 > A_7 > A_1 > A_5 > A_4 > A_6 > A_3$;

(c) Location factors: $E_3 > E_5 > E_2 > E_7 > E_4 > E_6 > E_1$;

(d) Market factors: $B_1 > B_3 > B_2 > B_5 > B_4 > B_6$;

(e) Technical factors: $D_2 > D_1 > D_3 > D_4$;

(f) Management factors: $C_1 > C_3 > C_4 > C_2 > C_5$;

(g) Obstacles to promoting PH in rural areas: $D_2 > D_1 > C_1 > E_3 > C_4 > C_3 > A_2 > D_3 > E_5 > B_1 > A_7 > D_4 > E_2 > A_1 > B_3 > B_2 > B_5 > B_4 > A_5 > E_7 > B_6 > A_4 > C_5 > E_4 > A_6 > C_2 > A_3 > E_6 > E_1$.

Based on the results obtained from factor analysis, we conducted a discussion. We explored the outcomes after sorting them across various dimensions. The sorting results of all tertiary indicators were then discussed. This approach helped us identify which issues should be prioritized and ensured that our research maintained logical coherence and focus. This analysis provides a solid foundation for subsequent improvement measures.

3.4.1 Policy factors

As seen in Table 5, among the obstacles to promoting PH in rural areas, the policy factor aspect (0.219) of the obstacles has a greater impact. This indicated that promoting prefabricated structures in rural contexts is characterized by unique challenges and necessitates a stronger emphasis on policy-level interventions. Specifically, the absence of tailored policies guiding rural residents (A2) and inadequate policy execution at the local level (A1) emerge as paramount concerns, surpassing other policy-related issues. The high taxation of prefab components (A4) also ranks high, indicating a need for fiscal reforms to stimulate the sector. Meanwhile, limited financing options for rural construction (A3) remain a relatively lesser challenge. All in all, there are deficiencies in the government's support policies for promoting prefabricated buildings in rural areas, and it is still necessary to establish and improve the laws and regulations related to prefabricated buildings. This, coupled with the insufficient knowledge among residents regarding these types of homes, results in a reluctance to adopt them without clear guidance. Additionally, the lack of supportive policies for enterprises involved in the research and development (R&D) and production of prefabricated rural housing leads to inadequate investment in product development. Local governments also struggle with understanding and disseminating PH policies, hindering the effective promotion of such policies.

3.4.2 Market factors

Market dynamics reveal that the affordability issue, encapsulated by high prefab unit prices (B1), takes precedence. Insufficient marketing efforts in rural zones (B2) outrank transportation costs (B5), suggesting a knowledge gap that must be bridged. High R&D costs with slow returns (B4) are prioritized over an incomplete industry chain (B6, correctly associated with market factors), emphasizing the necessity for investment in innovation and market maturation. In summary, prefabricated rural housing tends to be relatively more expensive compared to traditional housing, lacking a competitive edge in terms of pricing, which impedes its adoption in rural areas. The number of companies capable of designing, developing, and manufacturing prefabricated rural houses is limited, resulting in a narrow range of products and limited options for consumers. Furthermore, the inadequate promotion of PH in rural areas means that many residents have limited knowledge about it, adding to the difficulty of its dissemination.

3.4.3 Management factors

such as the lack of dedicated regulatory bodies for prefab housing in rural areas (C1), are prioritized, followed by outdated management systems within manufacturing firms (C3). These outrank personnel competency issues (C5), underscoring systemic rather than individual deficiencies. The absence of a comprehensive safety management system (C2) completes this tier, highlighting safety as a fundamental concern. In summary, there is insufficient regulatory oversight over rural residents' construction activities, especially in promoting prefabricated rural housing. The "who reviews, who supervises" approach can result in substandard PH proliferating in rural areas due to inadequate supervision. Although prefabricated construction has been mentioned for some time, progress in talent cultivation and management system establishment in China has been slow, leading to a shortage of professional

managers. The outdated management systems of component manufacturing enterprises might affect product quality, impacting the popularization of PH.

3.4.4 Technological factors

An incomplete standard system (D2) and limited product variety (D3) in rural prefab housing outrank interoperability issues (D4), suggesting that establishing a solid foundation for prefab technology and standards is crucial before addressing more nuanced technological challenges. In summary, an incomplete technical standard system is one of the main obstacles to promoting PH in the Jiangsu countryside. The lack of reliable and practical technical standards makes market supervision challenging. The maturity of PC, steel, and timber structural systems and their suitability for local natural and construction conditions all influence the promotion of PH. Moreover, as standardized products are produced in factories, prefabricated houses face challenges in meeting the personalized needs of rural residents in Jiangsu, necessitating better integration with local architectural features.

3.4.5 Location factors

Geographical and infrastructural considerations are pivotal, with narrow village roads (E3) significantly impacting prefab implementation more than spatial constraints due to housing density (E5). The relatively low seismic advantage of prefab in the region (E2) is of notable concern, reflecting a need to address regional specifics in prefab promotion. Residents in the Jiangsu countryside tend to be conservative in their thinking and less receptive (E7) to new things, preferring traditional building methods. Economic underdevelopment (E4) precedes industry fragility (E6) and weather phenomena (E1), suggesting broader socioeconomic conditions play a foundational role. In summary, although the overall transportation infrastructure in the Jiangsu countryside is generally favorable, narrow internal roads make transporting prefabricated components challenging. The small distances between rural houses limit the available space for the construction of PH, which restricts its adoption.

3.5 The strategies promoting PH based on SWOT analysis

3.5.1 Internal and external environment analysis

An analysis of the external environment for the promotion of PH in rural areas of Jiangsu reveals several opportunities and challenges. Firstly, the policy environment is highly favorable, with national and local governments providing strong support for PH through measures such as setting clear development goals and offering incentives and subsidies. This lays a solid foundation for the development of PH in rural areas of Jiangsu.

Secondly, there is a low level of satisfaction among residents with their existing homes, particularly regarding aesthetics, room layouts, and interior finishes, indicating significant room for improvement and demand. Furthermore, market research indicates a strong demand for new housing, especially in plains-type villages where building policies are relatively relaxed and a high proportion of people seeking to build new homes.

However, there are also significant external threats. The compact layout and narrow roads in rural areas of Jiangsu pose challenges to the transportation and construction of prefabricated houses, potentially hindering their promotion and expansion^[39]. Additionally, the lack of grassroots promotion and supervision mechanisms can lead to issues with construction quality and safety^[40]. Rural residents' conservative attitudes and cautiousness toward new technologies also increase the difficulty of promotion.

In terms of internal conditions, PH offers numerous advantages. Compared to traditional brick-and-concrete structures, prefabricated houses have higher structural stability, capable of withstanding earthquakes up to magnitude 8, and addressing common problems such as wall cracking and water seepage. PH also provides greater living comfort, incorporating energy efficiency and functional design considerations that improve winter insulation and summer ventilation. Factory production ensures high-quality and consistent components, reducing on-site workloads and difficulties, shortening construction periods, and lowering costs.

Despite these advantages, the promotion of PH in rural areas of Jiangsu faces some disadvantages. There is a shortage of specialized talent, including technicians, engineers, and managers^[41], which could impact project implementation quality. Moreover, prefabricated houses are generally more expensive than traditional houses, even though they offer better long-term economic benefits; rural residents tend to focus on initial investment costs. Lastly, the lack of unified standards and technical specifications in the PH market leads to a fragmented industry^[42], affecting regulatory effectiveness and limiting overall research and development capabilities and product competitiveness.

3.5.2 SWOT matrix diagram

To illustrate the promotion of PH in rural areas of Jiangsu, a SWOT analysis matrix has been constructed based on external opportunities and threats, as well as internal strengths and weaknesses. Firstly, the contents corresponding to internal strengths and weaknesses are placed at the top of the diagram, while external opportunities and threats are listed along the left side. Subsequently, these elements are combined pairwise to form strategies for the promotion of PH in rural areas of Jiangsu, including

Strengths-Opportunities (SO), Strengths-Threats (ST) , Weaknesses-Opportunities (WO), and Weaknesses-Threats (WT) strategies. The details of these strategies are presented in [Table 6](#).

Table 6. The strategies promoting prefabricated housing based on SWOT analysis.

	Strengths (S) a) Stable structural system, high value of dismantling and recycling; b) Reasonable layout, excellent thermal insulation performance, and good living comfort; c) Factory production with excellent quality; d) Green and environmentally friendly, short construction period.	Weaknesses (W) a) Lack of various professional talents; b) The market price of rural prefabricated housing is relatively high; c) Inconsistent standards and weak research and development capabilities for prefabricated residential buildings.
Opportunities (O) a) Policy support for the development of prefabricated housing; b) Low satisfaction with residential properties among rural residents in Jiangsu; c) Strong demand for rural housing market in Jiangsu.	SO Strategies a) Utilize policy advantages to expand market share; b) Capture residents' pain points and highlight product advantages; c) Adapt to market demand and optimize product structure.	WO Strategies a) Utilize policy dividends to increase research and development investment; b) Strengthen talent introduction and focus on professional talent cultivation; c) Expand scale, improve technology, and reduce residential prices.
Threats (T) a) The prefabricated policy does not pay enough attention to rural areas of Jiangsu; b) The compact layout of rural areas in Jiangsu is not conducive to transportation and construction; c) Lack of promotion and supervision management organizations at the grassroots level; d) Rural residents in Jiangsu have conservative thinking.	ST Strategies a) Optimize product design and improve construction technology; b) Improve the grassroots supervision system and promote orderly progress; c) Strengthen publicity and guidance, focus on interactive experience.	WT Strategies a) Clear policy support for the construction of prefabricated housing for rural residents; b) Improve the local standard system for prefabricated rural housing; c) Provide excellent pre-sales and after-sales services for rural prefabricated housing.

SWOT: strengths, weaknesses, opportunities and threats.

3.5.3 Exploiting strengths and opportunities (SO strategies)

1) Policy alignment and market penetration

Given the strong national policy support for PH, it is crucial to align local policies in Jiangsu with these directives. This can be achieved by formulating clear and targeted policies that incentivize rural residents to opt for prefabricated homes. Financial subsidies, tax exemptions, and preferential loans^[43,44] could significantly reduce the initial cost burden for buyers, making prefabricated homes more competitive in the market. Additionally, by leveraging dissatisfaction with existing housing conditions and the desire for improved living standards, promotional campaigns can highlight the benefits of PH, such as energy efficiency, durability, and shorter construction times, to attract potential buyers.

2) Tailoring solutions to local demands

Understanding the specific needs and preferences of rural residents is essential. Offering customization options that integrate local architectural styles and cultural elements into prefabricated designs can help overcome resistance to change. This approach not only meets aesthetic desires but also fosters a sense of belonging and cultural continuity, enhancing the appeal of PH in the region.

3.5.4 Overcoming weaknesses and seizing opportunities (WO strategies)

1) Streamlining production and lowering costs

Addressing the high upfront cost of prefabricated homes is a priority^[45]. Strategies to streamline production processes, including investing in automation and robotics, can reduce labor costs and increase efficiency. Additionally, expanding production capacity and adopting lean manufacturing principles can lower unit costs through economies of scale. Collaborative efforts between manufacturers and suppliers can further optimize supply chains^[46], reducing material costs and shortening delivery times.

2) Developing a skilled workforce and knowledge base

The lack of specialized professionals is a significant weakness. Establishing vocational training programs focused on prefabrication construction techniques, project management, and installation procedures can help create a skilled workforce capable of executing complex prefabricated projects^[47]. Partnering with local educational institutions to integrate prefabricated construction into curricula can ensure a steady pipeline of talent. Additionally, knowledge-sharing platforms and workshops can facilitate continuous learning and capacity building within the industry.

3.5.5 Mitigating threats and reinforcing strengths (ST strategies)

1) Establishing a robust regulatory framework

The absence of a unified standard system and inadequate regulatory oversight pose threats to the industry's growth. To counter this, the government should develop and enforce a comprehensive set of standards for PH in rural areas. These standards should cover aspects such as design, materials, quality control, and sustainability. Concurrently, establishing a robust monitoring and evaluation system^[43] can ensure compliance and maintain high-quality construction standards.

2) Fostering community engagement and acceptance

The threat of conservative mindsets can be mitigated by fostering community engagement. Public-private partnerships can organize interactive sessions, demonstrations, and pilot projects to showcase the benefits and dispel misconceptions about PH. Engaging local influences and early adopters can also generate positive word-of-mouth and social proof, accelerating acceptance.

3.5.6 Counteracting weaknesses and neutralizing threats (WT strategies)

1) Enhancing infrastructure and logistic efficiency

The compact layout of rural villages and narrow roads presents logistical challenges for prefabricated construction. Collaborative efforts between the government and private sector to upgrade infrastructure, such as widening access roads and improving transportation networks, can alleviate these constraints. Furthermore, adopting modular designs that are easily transportable and can be prefabricated with minimal site disruption can make prefabricated construction more feasible in rural environments.

2) Building resilience through innovation

To neutralize the threat of technological immaturity and limited customization, innovation must be prioritized. Encouraging R&D through funding and innovation hubs can drive the development of adaptable prefabricated systems that cater to diverse rural landscapes and climatic conditions. Moreover, integrating smart home technologies and renewable energy solutions can position PH as a future-proof and sustainable option^[48], aligning with global trends and enhancing its market competitiveness.

4. Discussion

4.1 Summary findings

This article aims to identify and address the obstacles to promoting prefabricated construction in rural areas of Jiangsu province and proposes effective countermeasures. Through a combination of literature review and factor analysis, three key findings emerge.

First, the study identified 29 obstacle factors across five dimensions for promoting PH in rural Jiangsu. Compared to existing related studies^[49], this study is comprehensive and detailed in its selection of dimensions and the coverage of obstacle factors, encompassing most relevant challenges. The five dimensions-policy factors, location factors, market factors, technical factors, and management factors-align with the conclusions of Dave, Shi and others^[6,23]. By considering location factors this study supplements existing knowledge, providing a more comprehensive understanding of the development of prefabricated rural houses more comprehensive. It not only expands and deepens the system of obstacle factors but also enhances the broad applicability and practical value of the research conclusions.

Second, in terms of the weight of secondary indicators, policy factors (weight = 21.9%) and location factors (weight = 21.5%) have significant impacts. The ranking is as follows: Policy factors > Location factors > Market factors > Technical factors > Management factors. The results show that addressing policy and location challenges should be prioritized to overcome the main obstacles to

promoting PH in rural areas. Supportive policies and improving rural location factors are crucial for creating a favorable environment for developing PH solutions in rural communities. This is different from the conclusions of Shen, Wu, and Wang^[3,9,24]. From the developers' perspective, Shen asserts that cost factors are the primary obstacle, likely due to developers' sensitivity to cost control during project development^[3]. Wu and Wang emphasize that technical factors are the major obstacles^[9,24], as the level of technology directly affects the quality, performance, and construction efficiency of prefabricated houses. However, this article concludes that policy and location factors are the top two key factors, offering a unique perspective. Policy factors play an essential leading and regulatory role in rural areas of Jiangsu Province. Moreover, the government and policies are of great importance in promoting the development of the industry and achieving technological breakthroughs, and they can create a better environment for the popularization of prefabricated buildings in rural areas^[50]. Location factors highlight the specific challenges associated with the development and promotion of prefabricated houses in rural areas. The unique geographical locations in rural areas, along with influencing factors such as rural residents' willingness to promote prefabricated buildings, can effectively analyze the particularities of rural areas. In similar studies with the background of rural areas in China, it has also been confirmed that the willingness of rural residents has a significant impact on the implementation of effective reforms in rural areas^[51]. Additionally, the SWOT analysis confirms that rural areas in Jiangsu Province face challenges such as inadequate infrastructure, high transportation costs, and limited market demand, all of which obstruct the promotion of prefabricated houses. Therefore, designating location factors as key obstacles aligns with the actual situation in rural areas of Jiangsu Province.

Third, among the tertiary indicators, factors such as an incomplete standard system and the lack of dedicated promotion and supervision departments at the grassroots level are identified as crucial. The overall ranking is: D2 > D1 > C1 > E3 > C4 > C3 > A2 > D3 > E5 > B1 > A7 > D4 > E2 > A1 > B3 > B2 > B5 > B4 > A5 > E7 > B6 > A4 > C5 > E4 > A6 > C2 > A3 > E6 > E1. The top-ranking obstacle factors-D2 (The standard system for rural PH is incomplete), D1 (The technical system of rural PH is not mature), and C1 (Lack of specific departments for promoting and supervising rural PH at the grassroots level)-are not categorized as policy or location factors, yet their importance should not be overlooked. For instance, the incomplete standard system represented by D2 can lead to a series of problems. Without clear and comprehensive standards, the quality and performance of rural prefabricated houses may vary greatly among manufacturers and construction projects. Additionally, without a mature technical system as indicated by D1, ensuring efficient production, accurate installation, and long-term stability of prefabricated components becomes challenging, potentially leading to increased construction difficulties, higher error rates, and ultimately, longer construction periods and higher costs. The lack of specific promotion and supervision departments at the grassroots level as denoted by C1 suggests that a lack of effective organization and guidance during the promoting rural PH.

4.2 Theoretical implications

The research on the obstacles to promoting PH in rural areas of Jiangsu province contributes to the existing knowledge in several aspects. First, it enriches understanding the factors influencing the adoption of PH technology in rural areas. Identifying and analyzing specific policy, market, management, technical, and location factors provides a more comprehensive framework compared to previous studies that may have only focused on a few aspects. Second, the findings of this study regarding the relative importance of different factors help to improve the theoretical discourse on the adoption and implementation of prefabricated building technology across diverse geographical and social contexts. Third, this study emphasizes the necessity of an integrated approach that considers multiple dimensions simultaneously. This impacts the theoretical perspective of sustainable development in rural areas by demonstrating that the successful promotion of PH requires not only technological progress but also supportive policies, market support, and effective management mechanisms. This comprehensive view contributes to the development of a more holistic theory of rural development and housing.

4.3 Implications for policy and practice

This research provides valuable insights for the Jiangsu provincial government and relevant agencies in effectively identifying and addressing obstacles to the development of PH during policy formulation and implementation. By clarifying the significance of key influencing factors, policymakers can prioritize those with the most substantial impact, optimizing resource allocation and enhancing policy effectiveness. Additionally, the improvement strategies derived from the SWOT analysis offer practical guidance for local governments in promoting the adoption of PH. This initiative aims not only to improve rural housing conditions and quality of life but also to support rural infrastructure development, stimulate local economic growth, and foster related industrial chains. Moreover, integrating prefabricated technology aligns with national policies advocating for sustainable development in the construction sector, reducing resource consumption and environmental impact. The findings underscore the importance of strategic policy interventions to advance the growth of PH, with far-reaching implications for both social and economic development.

4.4 Limitations and future research directions

This study focuses on rural areas in Jiangsu province, and the research results may not directly apply to other regions with different geographical, economic, and cultural characteristics. For example, regions with more mountainous terrain or different climatic conditions may encounter unique challenges in promoting PH. Additionally, the sample may not fully represent all stakeholders involved in PH in rural areas, potentially introducing biases in responses and overlooking relevant factors.

Future research could expand the scope to include other regions of China, allowing for a comparative analysis of the similarities and differences in promoting PH. This would provide a more comprehensive understanding of the factors influencing the adoption of prefabricated houses in rural areas across the country. In-depth case studies of successful and unsuccessful PH projects in rural areas could also be conducted to gain a better understanding of the actual challenges and solutions involved. Research can also explore the long-term sustainability of prefabricated houses in rural areas. This includes evaluating their environmental impact, energy efficiency over time, and the social acceptance and satisfaction of residents living in prefabricated houses.

5. Conclusion

This study systematically identifies the obstacles to promoting PH in rural areas of Jiangsu province. Through surveys and analyses, the weight values of various influencing factors were determined, leading to the identification of key factors. A SWOT analysis method was employed to address to integrate the internal conditions and external environment of PH, proposing strategies to enhance its promotion in Jiangsu province. The main research findings are as follows:

- 1) This study constructs a comprehensive indicator system based on an extensive analysis across five dimensions—policy, market, management, technology, and location—supported by 29 specific obstacle factors as tertiary indicators. The framework offers a systematic approach to analyzing the multifaceted challenges associated with promoting PH, enabling stakeholders to gain a comprehensive understanding of the interrelated factors at play.
- 2) The factor analysis indicates that policy factors have a significant impact on the promotion of PH in Jiangsu province, followed by location factors. Among the third-level indicators, the imperfection of the rural PH standard system has had a significant impact on the promotion of rural PH in Jiangsu province. Therefore, it is crucial to build a solid foundation of prefabrication technology, with the government playing a key role in policy-making and guidance. Digital technology can optimize the design process and improve construction efficiency, while also providing robust support in the formulation and implementation of technical standards. By closely integrating digital technology with these standards, the development of rural PH in Jiangsu province can be effectively promoted.
- 3) The SWOT analysis presents a strategic framework for promoting PH in rural Jiangsu. SO strategies focus on policy alignment and market penetration, tailoring solutions to local needs. WO strategies emphasize streamlining production and developing a skilled workforce. ST strategies advocate for a robust regulatory framework and community engagement to enhance acceptance. WT strategies highlight the importance of improving infrastructure and fostering innovation to mitigate weaknesses and threats. By implementing these strategies, stakeholders can effectively address the challenges of prefabricated housing, supporting sustainable development and improving living conditions in rural areas.

Declarations

Authors contribution

Wang R: Investigation, writing-original draft.

Chen C: Data capturing.

Zhou L: Statistical analysis.

Ni G: Conceptualization, methodology, writing-review&editing.

Conflicts of interest

Guodong Ni is an Editorial Board member of the journal and other authors declare that there are no conflicts of interest.

Ethical approval

According to the institutional research ethics guidelines, ethical approval was not required for this study as it consisted of an anonymous questionnaire survey and no collection of sensitive personal data.

Consent to participate

Participants were informed of the purpose of the study prior to participation, and completion of the questionnaire was considered as providing informed consent.

Consent for publication

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Availability of data and materials

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