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Research Article

Exploring Critical Success Factors for Green Housing Projects: An Empirical Survey of Urban Areas in China

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The trend of China's construction industry has gradually shifted from traditional high-consumption to efficient green development mode to achieve the new goals of energy conservation, emission reduction, and sustainable development. The successful development of green housing (GH) has become a major strategic choice. Given the smooth implementation and delivery of GH projects, this study aimed to assess the impact of critical success factors (CSFs) on GH development by identifying controllable CSFs. Firstly, 20 controllable CSFs were identified through literature review. Secondly, the data collected by the questionnaire were used for principal component analysis (PCA). The factor analysis showed that the CSFs can be summarised into five important principal components, namely, (1) project management factors, (2) personnel ability factors, (3) teamwork-oriented factors, (4) human resource factors, and (5) financial and constraint factors. Finally, multiple regression analysis was used to assess the importance of CSFs. Results showed that project management factors, personnel capacity factors, and financial and constraint factors exerted positive impact on the successful development of the projects, with project management factors having the greatest impact. This work provides not only useful information and practical guidance for enterprises in GH development practice but also certain reference value for building a sustainable development society in China.

1. Introduction

As a pillar of China's economic development, the construction industry accounts for a large proportion of energy consumption and environmental pollution [1]. According to the "China building energy consumption research report (2018)," building energy consumption showed a continuous growth trend from 2012 to 2016, accounting for 20.6% of the total national energy consumption. Meanwhile, greenhouse gas emissions from building energy and other pollution phenomena have become increasingly serious. The total carbon emissions from urban buildings in China increased to 1.96 billion tons, accounting for 19.4% of the total energy emissions in China. The per capita resource shortage of large population has become unbearable and directly affects the whole society's sustainable development capacity [2]. Therefore, shifting from traditional high-consumption to efficient green development mode is an inevitable trend in the construction industry [3].

At present, several countries advocate new goals for energy conservation, emission reduction, and sustainable development in the construction industry and green building (GB) has become a strategic choice worldwide [4]. GB is usually defined within the entire life cycle of saving resources, protecting the environment, reducing pollution, and providing people with healthy, applicable, and efficient use of space, where the maximum limit realises the person's natural harmonious coexistence with high-quality construction. Large-scale development of GBs not only controls the overall goal of building energy conservation but also reduces the pollution during the implementation of building projects [5]. As an important form of GB, green housing (GH) is a new housing model designed and built based on the principle of sustainable symbiosis between man and nature and the principle of efficient utilisation of resources, which can make the internal and external material energy systems of the house virtuous cycle and achieve a certain degree of self-sufficiency in energy without waste and pollution. It can effectively save energy, protect the ecological environment, and improve the living satisfaction of consumers in later operation [6]. Therefore, the GH industry is an inevitable trend in the development of the building industry and the direction of future housing market.

To promote the development of GBs, the State Council has already integrated the concept of green development into the urban and rural planning and construction management. At present, the scale of development of GH has not reached the market expectations. According to the data of the Green Building Evaluation Marking Network, from 2008 to 2015, GB has an upward trend in the construction area and the number of projects in China. However, a large gap exists between the annual building area of GH and the total annual area of completed residential buildings. The highest proportion of 13.68% only was recorded in 2015. In addition, the number of GH in China accounts for a large proportion of GB. However, since 2011, the proportion has gradually declined. The above situation is still far from the goal "by 2020, the urban GB area will account for 50% of the newly built building area" in the "13th Five-Year Plan"; this phenomenon indicates that the development speed and scale of GH cannot be matched with the rapid development of the residential market [7]. Further accelerating the development speed and scale of GH can effectively promote China's new urbanisation construction and sustainable development as well as realise the transformation and upgrading of the residential market and construction industry [8].

China has adopted a series of policies related to GH, including mandatory laws and regulations, financial incentives, and tax incentives and encouraged more private and public owners to pursue GH to promote the development of GH projects [9, 10]. GH is a new building concept that requires new technologies, environmentally friendly materials, reliable simulation analysis, and complex architectural design and is a great challenge for project managers [11]. To ensure quality and safety, green construction must minimise the negative impact on the environment. Examples include strengthening the control of noise, dust, and construction waste and efficient use of materials and resources [12]. Although the green construction technology reduces environmental pollution and simplifies the construction process, the application of construction materials and technology is also a major problem [13]. The choice of building materials not only meets the requirements of green and environmental protection but also has high requirements for construction methods. For example, the prefabricated wall should not only use composite insulation and waterproof materials but also generally adopt the assembled construction method. It has strict requirements and high construction standards for the stacking, lifting, and grouting processes of the components [14]. None of these has appeared in traditional construction methods. Therefore, the green construction method has more difficulties compared with traditional construction methods. Many studies have shown that more than half of the surveyed projects encountered problems during development due to the complexity of GH projects [15]; cost management and productivity performance in GH are difficult to cope with compared with the traditional GH project development plan [16, 17], and many projects have failed or been abandoned [18]. However, the academic and architectural communities still lack sufficient experience to provide practical solutions to problems and management strategies for the system [19]. Systematic awareness of the critical success factors (CSFs) of GH is lacking in terms of the design, construction, management, and operation phases [20, 21], thereby hindering the sustainable development of GH.

In view of these issues, this study aims to (1) identify CSFs for GH and (2) assess the impact of CSFs on project management objectives. The results are expected to fill the gaps in GH project management research and provide useful information and practical guidance on GH development practices. To promote the successful development of GH, practitioners can customise their CSF list throughout the life cycle of their GH projects based on the factors identified to effectively achieve sustainable development in the construction industry. Figure 1 shows the main framework processes.

2. Identification of CSFs

CSFs help to achieve the desired goals and are undoubtedly essential to the success of the project [22]. Therefore, a specific list of CSFs is very important for successful execution of a project throughout its life cycle. CSFs were once considered "an area of activity where key results are absolutely necessary for the manager to achieve his or her goals." In the past few decades, CSFs, which explore the impact of project development, have received special and continuous attention [23, 24]. In essence, CSFs have always been the focus of researchers on the promotion and development of GH. For example, Zhen [25] analysed the reasons for the slow development and the obstacles of constructing low-carbon buildings in Chinese cities. The study concluded that the usual focus included construction cost, policy content, and public perception [26]. Li et al. [21] explored the key success factors affecting the performance of the Singapore Green Label Certification project; they found that "coordination between designers and controllers" and "technical and innovation-oriented factors" are the most influential factors. Shen et al. [27] systematically examined the key success factors of GBs from the perspective of project participants in Thailand; the results indicated that "capability of individual participants" and "integration of project team" could significantly affect the delivery of GB projects. Zuo et al. [28] summarised the key success factors of achieving carbon neutral architecture in Australian commercial architecture from the perspective of stakeholders; the factors include market, technology, and policy (government support, regulation, and demonstration project). With the increasing number of GB projects, the exploration of CSFs for GH projects will continue to gain academic interest in the future. The present study conducted a comprehensive literature review of CSFs for GH projects by following the methods proposed by Hwang et al. [17, 29].

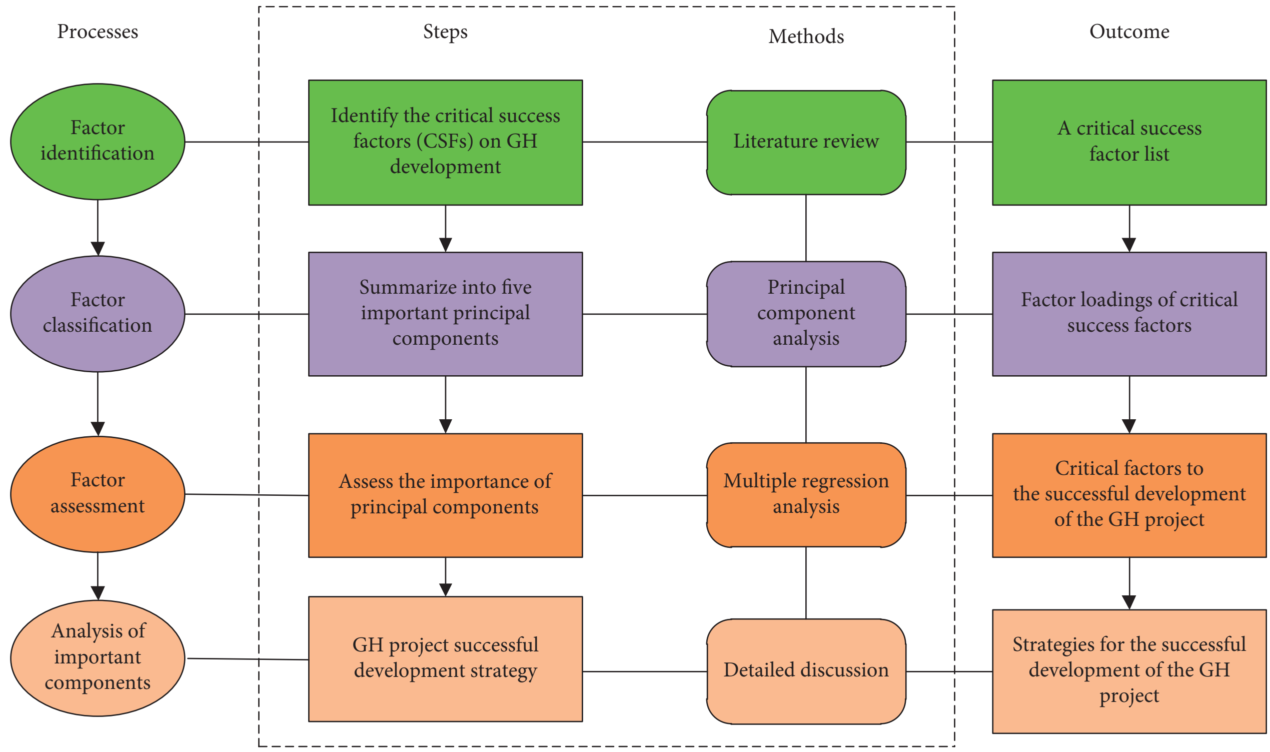

Figure 1: Research framework.

External Incentives and Constraints. Sufficient financial resources can bear the high development cost of GH, which can effectively mobilise the enthusiasm of enterprises to develop GH [8, 11]. For example, the banks' loan concessions can alleviate the financial pressure of enterprises to develop GB to a certain extent and improve their willingness to develop GB [27, 30]. At the same time, the government's economic incentives and regulatory measures are important considerations for companies to make GH development decisions [31]. The government provides incentives for the development of GH projects, supervises the construction management of contractors, and reduces the tax credits for homebuyers [18, 32]. These strategies have effectively motivated the construction of GH and improved the willingness of consumers to purchase. In addition, the technical specifications of GH are crucial. The performance standard of GH is higher than that of traditional housing [30, 33]. The perfect technical specifications have effective restraint and guidance for the construction of GH.

Technology and Project Management. GH is a new type of building that requires new technologies, environmentally friendly materials, reliable simulation analysis, and complex architectural design; this concept integrates a large number of advanced and complex technologies, which not only has higher requirements on the construction capacity of enterprises but also generates higher incremental costs in terms of human resources, materials, and machinery. Therefore, technical innovation [34] and effective cost management [35, 36] are crucial in the construction and delivery of GH projects. According to the successful cases of GH projects, more uncertainties and complexities in the project process and risks are unrecognised or even unpredictable compared with traditional housing. Hence, the perfect risk management system not only helps the project to achieve the expected goal in terms of time, cost, and schedule but also deals with numerous unexpected risks and ensures the success of the project [17, 37, 38].

Ability and Quality of the Participants. At the strategic level of the GB project, the support and capabilities of senior management play a positive role in achieving the GH project management objectives; their correct decision-making and guidance contribute to the realisation of high-performance and high-level GB projects [35, 39]. GH projects have greater uncertainty and complexity than traditional housing. Therefore, at the project implementation level, a well-equipped project manager can greatly improve the project performance [37, 40]. The sufficiency of design details and specifications is as important as the designer's choice given that the design of GH is more complex than that of traditional housing [17]. In addition, the use of well-trained and highly skilled workers in green projects can contribute to the successful construction of GBs. A clear project goal and purpose will help participants better understand the GH projects and make the whole project development process more direct and smoother

[35, 41]. Studies have pointed out that the participation of end users can improve the success rate of GH projects [30, 42]. Users' opinions and suggestions can make the housing design more humanised and meet their needs.

Collaboration of Project Team. The construction of the GB project is a complex systematic task [18, 43]. Effective communication and collaboration between project team members can effectively reduce the complexity of GH projects and create greater flexibility in the implementation process to ensure the smooth delivery of the project [17]. Good trust relationships [18, 33] and team motivation [18, 44] are two important factors that can improve the efficiency and enthusiasm of the entire project team and make an important contribution to achieve project goals. The project management of GH, a sustainable new building, is quite different from that of traditional buildings. Therefore, the management education and training of the project team is indispensable [45, 46]. In addition, once GH is built, fast and effective feedback and troubleshooting are important [47]. The company must provide guidance and support to ensure the smooth operation of GH, including marketing, information and program support, troubleshooting, and rapid response to user needs.

Finally, the study identified 20 factors that may influence the development of GH (Table 1).

Table 1: Critical success factors for GH.

Code	Critical success factors	References
CSF1	Adequate financial resources	[8, 11, 30, 46]
CSF2	Effective government policies and regulatory	[27, 30, 31]
CSF3	Owner's active participation and commitment	[37, 41, 43, 48]
CSF4	Technology specification	[30, 33]
CSF5	Senior management support	[35, 37, 39, 49]
CSF6	Project manager's ability	[24, 30, 37, 40]
CSF7	Designer's ability	[17, 38, 50]
CSF8	Worker's experience and skill level	[17, 33, 42]
CSF9	Clear project goals and objectives	[35, 41, 49]
CSF10	End user's participation	[30, 42, 51]
CSF11	Stakeholder's active participation	[18, 42–44]
CSF12	Effective collaboration and communication	[17, 38, 39, 52]
CSF13	Good trust relationships among stakeholders	[18, 33, 46]
CSF14	Team motivation	[18, 27, 44, 46]
CSF15	Team's education and training	[45, 46]
CSF16	Effective feedback and troubleshooting	[47]
CSF17	Effective cost management	[30, 35, 36, 42]
CSF18	Advanced machinery and innovative technology	[17, 33, 34]
CSF19	Project risk management	[30, 32, 46]
CSF20	Effective project planning and control	[17, 37, 38, 53]

3. Research Method

3.1. Questionnaire Design. Through the analysis and summary of the literature, the study identified 20 GH project success factors that have an important impact on the management and performance of the green mark certification residential project. A questionnaire was designed for evaluation to rank the 20 CSFs that achieve green mark certification. The questionnaire consists of three parts. The first part aims to obtain the basic information of the respondents, including the work area, role, construction, and GH experience years. The second part requires each respondent to rate the factors by a Likert scale measurement (1 being "strongly unimportant" to 5 being "strongly important"). The third part provides open questions for respondents, who can list other success factors not mentioned in the questionnaire as well as suggest any improvement.

After the preliminary design of the questionnaire, its validity and relevance were tested by a two-step method to ensure its rigor and relevance. The questionnaire was first reviewed by the survey problem construction expert to ensure that it does not contain any common mistakes, such as confusing or double problems. A pilot study was then conducted to test the relevance of the items to the topic. The pilot survey consisted of eight participants. Four of the participants are certified GB project managers with 5 to 10 years of work experience, mastered GB project management knowledge and skills, and have the ability to solve the building's life cycle; the remaining four are scholars who have successfully delivered research experience to GB projects in the past 10 years. In the pilot study, the unreasonable design of the questionnaire was pointed out and corrected and it was finalised. In the presurvey interview, the participants obtained the results from the questionnaire. The participants confirmed that the results of this study were reasonable and in line with their expectations, which helped to validate the findings. Therefore, the study was officially administered in China.

3.2. Data Collection and Analysis. To reflect objectively the CSFs of GH development in China's urban areas, according to the statistics of the Green Building Evaluation and Marking Network, Figure 2 shows the ranking of China's GB marking project area (the darker is the colour, the larger is the area). Figure 3 shows the ranking of the amount of GB marking project in various regions of China. Through comprehensive survey data, this study selected the top seven cities in China in terms of number and area of GB identification projects. The cities include Jiangsu, Guangdong, Shanghai, Shaanxi, Shandong, Hubei, and Zhejiang, which have a strong representative in the national GB identification project.

The target respondents of the questionnaire are professionals and senior managers in the construction industry, including project managers, architects, consultants, and other stakeholders with GB-related experience. The survey was conducted by 21 well-trained investigators, with three in each group. The teams contacted the professionals of companies with green logo certification programs in seven provinces and cities to distribute questionnaires in the

Figure 2: Green building evaluation marking project map.

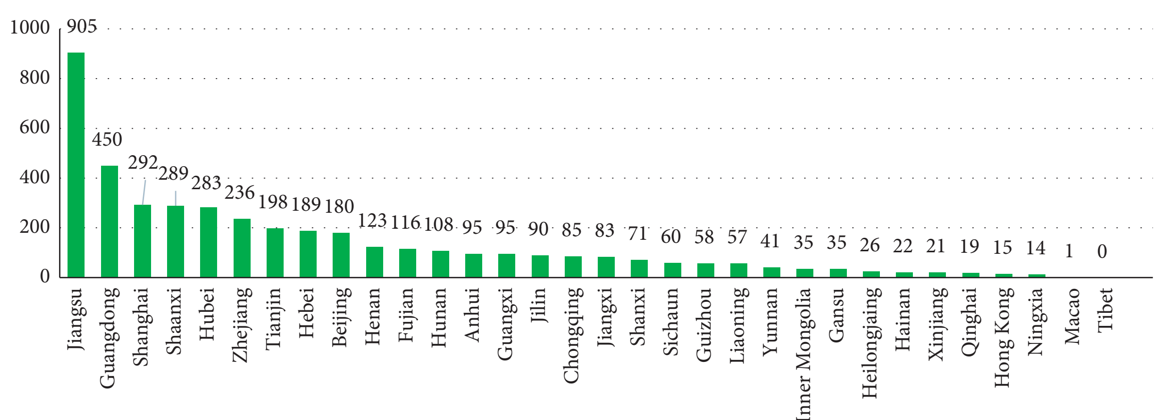

Figure 3: Green building evaluation marking project statistics.

survey areas. In this study, 138 questionnaires were distributed through field survey and e-mail from February to May 2019, and 91 questionnaires were subsequently collected. In the data screening process, incomplete and blank questionnaires were eliminated and 76 questionnaires were finally used for data analysis. The actual response rate was 65.9%, and the effective response rate was 83.5%. Although the sample size was not large, statistical analysis can still be performed because, according to generally accepted rules, the central limit theorem holds when the sample size is not less than 30 [54, 55]. Thus, 76 final samples met the requirement.

The survey data were analysed using Social Science Statistics Package (SPSS) software. Firstly, the reliability of the five-point scale used in the survey was determined using Cronbach's alpha coefficient. Secondly, PCA was performed to reduce 20 CSFs to fewer independent factors because the existence of correlations between these factors may affect the results of multiple regression analysis. Finally, multivariate stepwise regression analysis was used to analyse the relative impact of factors extracted from factor analysis on the development of green mark building projects.

4. Survey Results

4.1. Profiles of Respondents. The basic information of the respondents is shown in Table 2. The largest group of respondents comprised senior management, followed by project managers, accounting for 35.5% and 18.4%, respectively. Architects and engineers accounted for 14.5%

Table 2: Profile of respondents.

Variable	Group	Frequency	Percentage of total (%)
Region	Jiangsu	15	19.7
	Guangdong	13	17.1
	Shanghai	11	14.5
	Shaanxi	11	14.5
	Shandong	10	13.2
	Hubei	9	11.8
	Zhejiang	7	9.2
Respondent's role	Engineer	9	11.8
	Consultant	5	6.6
	Architect	11	14.5
	Project manager	14	18.4
	Senior manager	27	35.5
	Researcher	6	7.9
	Others	4	5.3
Years of experience in the construction industry	5–10 years	8	10.5
	10–20 years	48	63.2
	More than 20 years	20	26.3
Years of experience in GB projects	Less than 5 years	14	18.4
	5–10 years	23	30.3
	More than 10 years	39	51.3

and 11.8% of the respondents, respectively. Researchers and consultants accounted for 7.9% and 6.6%, respectively, of which researchers represented a wealth of theoretical knowledge and practical experience in GB. The remaining respondents accounted for 5.3%, which represented professionals from the Green Building Certification Organisation and related commissions. Of the respondents, 63.2% had 10 to 20 years of experience in the construction industry, which is the main survey group. Meanwhile, 26.3% of the respondents had more than 20 years of industrial experience, and no respondent had less than 5 years of work experience. In addition, 76 respondents in this survey had experience in the GB projects. Half of them (51.3%) had more than 10 years of experience in GB projects, and only 18.4% had less than 5 years of experience in GB work.

The brief introduction of the respondents showed that the survey was evenly distributed geographically, and the comprehensive ranking of GB projects in China was high. Most of the interviewees were senior and project managers who had strong professional knowledge and management ability. Moreover, the role of interviewees covered a wide range, which was representative in the industry. All the interviewees were working in the construction industry; most of them participated in the GB projects and were highly targeted. Overall, the data collected in this survey were highly reliable and representative, which ensured the validity of the data to an extent.

4.2. Internal Reliability. Cronbach [56] proposed an alpha statistic for evaluating the variables of the internal consistency dataset; this tool is commonly used for reliability measurement. Cronbach's alpha (α) has a value that ranges from 0 to 1. A value close to 1 indicates high consistency of variable values, while a value close to 0 indicates low correlation between variables. Scholars believe that α should be at least 0.8 in basic research and 0.7 in exploration study. In the practical study, α only needs to reach 0.6 [57]. By using SPSS software to test the official survey data, Cronbach's alpha (α) value is $0.908 > 0.7$, which indicated that the CSFs have high internal consistency and high reliability. The reliability of the questionnaire can be used for further analysis.

In addition, this study calculates the statistical mean and standard deviation of each important factor. As shown in Table 3, except for end user's participation, the mean values of all CSFs are higher than the midpoint of the ratio, which means that the identified factors have a high impact on the successful delivery and development of GH. The main value of end user's participation is 2.78, which is the lowest mean score. This shows that end users still adopt the traditional housing view. Project manager's ability has the highest mean score, which indicates that the project manager's ability plays an important role in the construction of GH and the environmental performance of the building projects.

4.3. Principal Component Analysis (PCA). PCA is an analytical method that assesses the correlation between variables and performs dimension reduction classification according to the correlation between variables [58]. Before performing factor analysis, a Kaiser–Meyer–Olkin (KMO) test and a Bartlett test of sphericity are performed on the sample data of the survey to determine whether the sample data are suitable for factor analysis. The KMO value is mainly used to detect the degree of correlation between variables. When the KMO value is greater than 0.5, the correlation of the sample data is better. The Bartlett test of sphericity is mainly used to detect the degree of significance between variables. The Sig value of less than 0.05 in the test results indicates that the significance between the variables is better, and the KMO and Sig test criteria indicate that the survey sample is suitable for factor analysis [59]. In this study, the value of the KMO index was 0.859 (greater than 0.5) and the Sig value of the

Table 3: Mean, Median, and SD of critical success factors.

Code	Critical success factors	Mean	Median	SD
CSF9	Clear project goals and objectives	4.46	5.00	0.729
CSF16	Effective feedback and troubleshooting	4.17	4.00	0.695
CSF17	Effective cost management	3.98	4.00	0.892
CSF18	Advanced machinery and innovative technology	3.86	4.00	0.663
CSF19	Project risk management	3.61	4.00	0.987
CSF20	Effective project planning and control	3.85	4.00	0.802
CSF3	Owner's active participation and commitment	3.98	4.00	0.683
CSF5	Senior management support	3.26	3.00	0.853
CSF10	End user's participation	2.72	3.00	0.782
CSF11	Stakeholder's active participation	3.48	3.00	0.774
CSF12	Effective collaboration and communication	3.86	4.00	0.942
CSF13	Good trust relationships among stakeholders	3.52	3.00	0.839
CSF14	Team motivation	3.37	3.00	0.795
CSF15	Team's education and training	3.85	4.00	0.997
CSF6	Project manager's ability	4.52	5.00	0.692
CSF7	Designer's ability	4.00	4.00	0.804
CSF8	Worker's experience and skill level	3.77	3.00	0.715
CSF1	Adequate financial resources	3.93	4.00	0.974
CSF2	Effective government policies and regulatory	4.02	4.00	0.932
CSF4	Technical specification	3.54	3.00	0.841

Bartlett test of sphericity was $0.000 < 0.05$. The test results showed significant correlation between the variables of the questionnaire, and the data were suitable for further factor analysis.

PCA is used to evaluate the relationships between variables and attempts to recombine multiple variables into a new set of mutually independent composite variables (principal components) [60]. This step is divided into two processes [61]. The first process is factor extraction. SPSS software is used to reduce the dimensionality of 20 indicators. The obtained results and eigenvalues are shown in Figure 4, where the histogram represents the characteristic value and the polyline represents the cumulative variance contribution rate of original variables. One of the most commonly used criteria for determining the number of factors is the minimum eigenvalue criterion. The eigenvalue of the factor is the variance that the factor can explain. If the eigenvalue of a factor is ≤ 1, then this factor can only explain the variance of one index or even cannot completely explain it. However, the purpose of factor extraction is to explain the variance of all indexes with as few factors as possible. Thus, the explanatory power of this factor is insufficient. Therefore, the minimum eigenvalue method requires that only the factors with eigenvalues greater than 1 are retained [62]. It can be found from Figure 4 that the eigenvalues of the first five factors were greater than 1, so the first five factors were selected as common factors. The contribution rate of the common factor to the cumulative variance of the original variable reached 86.807%, which indicates that the 5 common factors can well reflect the overall change of the 20 indicators [63]. Therefore, the five components can be used to represent the original indicators for further research. The second process is factor rotation. Factor rotation of the initial common factor load matrix was conducted using the Kaiser standardised orthogonal rotation function of SPSS software to verify that the extracted principal components are more representative and that the contribution rate is clearer and more reliable. The factor load after rotation is shown in Table 4.

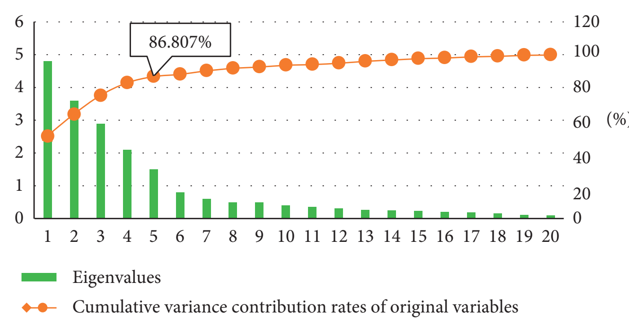

Figure 4: Scree plot chart of principal components.

Table 4 shows the factor loading of CSFs in the five principal components and the correlation system between the original variables and the extracted components. Therefore, the larger the factor load, the higher the contribution rate to the principal component. A factor load greater than 0.5 is considered important for the interpretation of the principal component; otherwise, it is considered trivial [64]. Table 4 shows that all the factor loads are greater than 0.5. To distinguish better the identified CSFs and the extracted principal components, this study renamed the five principal components extracted, and there is no factor equipped with double loadings. The results are as follows.

Component 1 consists of six factors, which are clear project goals and objectives, effective feedback and troubleshooting, effective cost management, advanced machinery and innovative technology, project risk management, and effective project planning and control. These factors are all in the project management process, mechanical and technical updates, clear objectives, and good

Table 4: Factor loadings of critical success factors.

Components	Code	1	2	3	4	5
Project management factors	CSF9	0.902	0.104	0.028	−0.084	0.003
	CSF16	0.874	0.002	0.174	−0.208	0.133
	CSF17	0.827	0.056	0.036	−0.087	0.021
	CSF18	0.789	−0.060	0.098	−0.032	0.143
	CSF19	0.755	−0.132	0.081	−0.004	0.113
	CSF20	0.693	−0.178	0.028	−0.095	0.017
Human resource factors	CSF3	0.182	0.869	−0.077	0.029	0.110
	CSF5	0.026	0.790	−0.006	0.025	−0.112
	CSF10	0.031	0.732	−0.103	0.048	−0.029
	CSF11	−0.009	0.706	0.109	0.002	0.131
Teamwork-oriented factors	CSF12	0.110	0.034	0.697	0.004	0.029
	CSF13	0.149	0.101	0.683	0.099	0.026
	CSF14	−0.020	0.093	0.641	0.043	0.103
	CSF15	−0.006	0.118	0.626	0.014	0.182
Personnel ability factors	CSF6	0.090	0.005	0.022	0.776	0.131
	CSF7	0.133	0.019	0.183	0.735	−0.063
	CSF8	0.015	−0.008	0.009	0.731	−0.007
Finance and constraint factors	CSF1	0.001	0.100	0.102	0.134	0.853
	CSF2	−0.085	0.174	0.172	0.184	0.784
	CSF4	0.026	0.144	0.129	0.007	0.737

overall control to help achieve the project plan. Therefore, this component is called project management factors. This component shows the biggest difference among all components (50.3%).

Component 2 consists of four factors, which are owner's active participation and commitment, senior management support, end user's participation, and stakeholder's active participation. Stakeholders are important resources for project success and development. These factors are closely related to the human resource management of the project organisation. Therefore, this component is called human resource factors.

Component 3 consists of four factors, which are effective collaboration and communication, good trust relationships among stakeholders, team motivation, and team's education and training. These factors are closely related to the communication and cooperation of the project team. A work team with a good working atmosphere is conducive to the smooth progress of the project. Therefore, this component is called teamwork-oriented factors.

Component 4 consists of three factors, which are project manager's ability, designer's ability, and worker's experience and skill level. These factors emphasise the ability and experience of project participants. Strong work abilities and experience have a positive impact on project management and implementation. Therefore, this component is called personnel ability factors.

Component 5 consists of three factors, which are adequate financial resources, effective government policies and regulatory, and technical specification. These factors are related to and constrained by external economic resources, policies, and norms. Therefore, this component is called finance and constraint factors.

The above five extracted principal components represent success factors that GH participants considered important. Although not all are project success factors, they covered almost all factors.

4.4. Regression Analysis. In PCA, CSFs are grouped according to the degree of correlation between them. However, the factor analysis did not calculate which of the five principal components had the greatest impact on the successful development of GH projects. Therefore, stepwise multiple regression analysis is used to find the independent variables that have significant predictive power for the criterion variable from several independent variables to form an optimal regression analysis model. The specific process is shown in Figure 5.

On the basis of the conclusion of the above PCA, the successful development of GH projects is mainly affected by project management factors, human resource factors, teamwork-oriented factors, personnel ability factors, and finance and constraint factors. In China, assessment standard for GB is the basis of GB certification. On the basis of the degree of meeting the evaluation terms, GBs are divided into three grades, namely, one, two, and three stars. The higher the star rating is, the better the performance of the GB will be. Therefore, in this study, the star level of GH projects is the dependent variable and the five components are the independent variables. Stepwise multiple regression is conducted with SPSS22.0. The regression results are shown in Tables 5 and 6.

Table 5 lists the R^2 decision coefficients, adjusted R^2, and significance for the regression model. The R^2 value of these three components is 0.421, which can explain the successful implementation of 42.1% of the GH projects through this model. The R^2 value is not very high, which is not surprising, as this model contained only controllable factors. However, more uncontrollable factors could affect the implementation of GH, such as external environmental conditions and internal organisational environment. The adjusted R^2 value is 0.407, the F value is 8.194, and the P value < 0.001, indicating that the model has good goodness of fit and can be accepted. The Durbin–Watson value is 2.301, which is between 1 and 3, indicating that the variables in the model are independent [65].

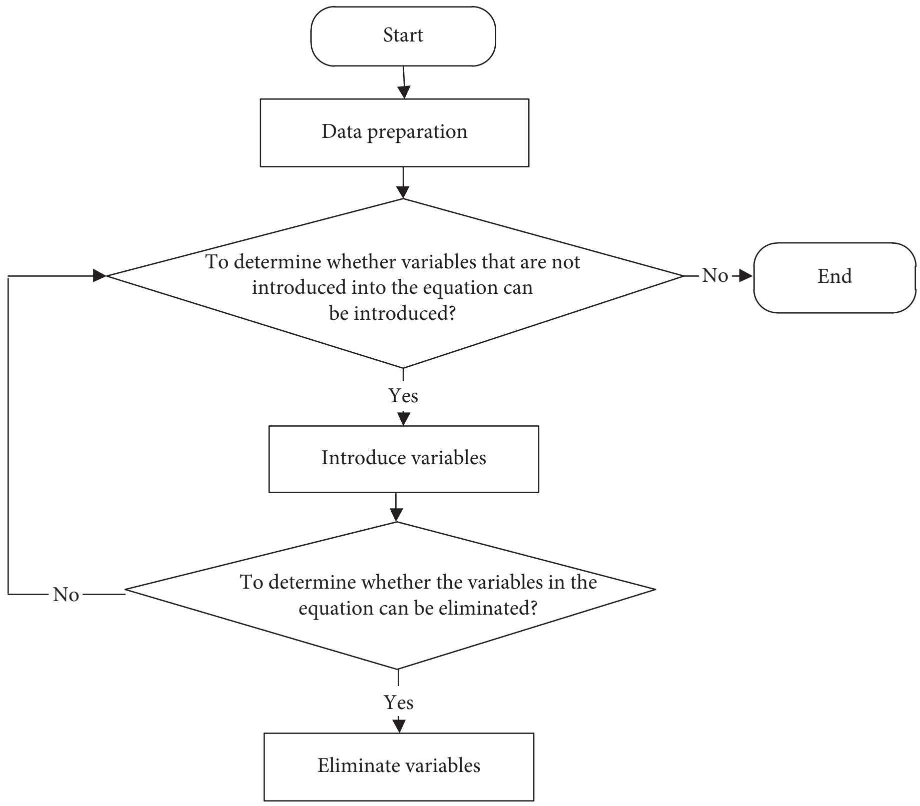

Figure 5: Specific process of stepwise regression analysis.

Table 5: Model fitting result.

R^2	Adjusted R^2	F value	Significance	Durbin–Watson value
0.421	0.407	8.194	<0.001	2.301

Table 6: Stepwise multiple regression results.

Independent variables	Beta coefficient (β)	Standard error	T value	Significance
Project management factors	0.450	0.051	7.012	<0.001
Personnel ability factors	0.373	0.047	6.081	0.001
Finance and constraint factors	0.309	0.045	5.886	0.010

Table 6 shows the results of stepwise regression analysis, listing β, standard error, T value, and significance. Teamwork-oriented factors and human resource factors were excluded from the model, but this exclusion does not mean that they are irrelevant; their impact is not as high as the three other principal components. Project management factors (P <0.001), personnel ability factors (P = 0.001), and finance and constraint factors (P = 0.010) had positive effect on the successful development of GH. According to the β and T values, project management factors are considered to be the most important and have an important impact on the successful development of GH.

5. Discussion of Findings

On the basis of the results of regression analysis, this study focuses on a detailed discussion of the five components that affect the successful development of GH projects. Particularly, project management factors, personnel ability factors, and financial and constraint factors are the three most important ones.

Table 6 shows that project management factors have positive impact on the successful development of GH projects (beta = 0.450) and the degree of impact is the highest. This result means that the project management factors are the most important factors influencing the success of GH projects, and the more perfect the project management work is, the higher the success rate of GH projects will be. Management and organisational issues are the major obstacles to development of GB. At the company level, the development experience of GH projects is usually limited. In this case, detailed management planning is indispensable, which systematically sets out project objectives of each stage and overall and conducts prior prediction and control to risks that may occur during project development. Under the guidance of the management plan, all stages of the project can work in an orderly manner and achieve smooth coordination and cooperation with one another [38]. At the project level, in comparison with traditional residence, GH construction process is more complex and scientific project management is important. This process can effectively coordinate and control the construction process and handle various unexpected risks in a timely and effective manner to realise project performance objectives [53]. In addition, from the current perspective, problems occur frequently in the operation stage of GH due to the lack of effective maintenance and management. Rainwater recovery systems, for example, are undeniably efficient at saving water, although their economics are often compromised by neglect of management. Therefore, during GH operation, daily maintenance and management can maintain it in a good state for a long time to ensure the continuity of GH performance [66]. Project management factors run through the entire life cycle of a project, which also enlightens decision makers and implementers of GH projects to establish the idea of a complete life cycle management. The company shall make various management plans and risk response measures. In the implementation process, the project team shall effectively coordinate and control all construction processes of the project according to the predetermined goals. Daily maintenance and management of GH should be strengthened during the operation stage to ensure the successful delivery of the project.

Table 6 shows that personnel ability factors are positively correlated with the successful development of GH projects (beta = 0.373). The higher the ability of personnel is, the higher the success rate of the GH projects will be. Designers, project managers, and construction workers play important roles in enterprise capability. Different from traditional housing, sustainable building is a healthy, resource-saving building designed according to ecological principles. GH must meet the requirements of the green sign project and implement sustainable or green design in strict accordance with the technical specifications and performance requirements of GH. An increasing number of countries have strengthened their assessment of GH certification, including energy, materials, and carbon dioxide emissions [67]. Therefore, good design is the key to improve GH sustainability, which is directly related to the professional ability of designers. In addition, as a key figure in the construction stage of GH, project managers are important to the development of GH. Their job is to lead the project management team and manage project activities [45]. During project implementation, project managers guide the project team to run the construction in strict accordance with the design specification and perform early warning, prevention, and control of risks in a timely manner [67]. Therefore, experienced and capable project managers are critical to the successful delivery of GH projects. At present, the problem of workers' skill level cannot be ignored. The lack of green technical skills of workers and nonstandard construction operation process are considered obstacles related to the labour capacity of GH projects. Hwang and Leong [68] pointed out that improving workers' skill level can enhance project productivity by saving potential cost of labour. Workers with higher productivity will show better output. Therefore, more green skill training should be provided for workers, and on-site experience exchange meeting of GH projects should be held to improve construction experience and skills.

Table 6 shows that financial and constraint factors had positive impact on the successful development of GH projects. This finding indicates that the more abundant the funds and the stricter the regulations are, the higher the success rate of the GH projects will be. The project is characterised by high cost and long investment return period. In the Chinese market, the lack of financial ability of developers has led to low participation. On this basis, the financial support and incentive policies provided by the central and local governments are a great opportunity for GH investors, such as loan concessions and financial subsidies, which can not only reduce the tax liability of investors but also realise the economic incentives of indirect subsidies and improve the level of GH investor benefits, thereby promoting the construction for investors to GH [69]. Meanwhile, the formulation and constraint of national policies and technical norms are also indispensable. In the course of GH development in developed countries, Britain, Germany, France, and other countries have revised their GB implementation standards many times, which has played an effective guiding role for the development of GH [70]. At present, the Chinese government has formulated a series of laws and implementation standards for GB, but problems, such as vague provisions, insufficient enforcement, and supervision, still exist. Therefore, the system and the improvement of the top-down comprehensive policy and supervision system are important for the implementation of GH, including policies, laws, standards, technical specifications, certification systems, and regulatory systems at all levels, to establish a set of effective supervision and management mode in the form of specialised standards and regulations regulating the behaviour of the implementation of the GH to improve the success rate of GH [69]. In short, financial and constraint factors play a dual role. On the one hand, they encourage investors to improve the enthusiasm of GH development. On the other hand, they establish a standard implementation and supervision system to strictly regulate the entire process of GH management, which plays a positive role in the successful development of GH projects.

The influence of teamwork-oriented factors and human resource factors are not as high as that of the first three principal components, but they are still relevant to the successful development of GH. Therefore, the two factors are also discussed in this study.

As a new type of housing, GH projects usually apply many advanced energy-saving technologies and must meet strict technical specifications. The complex construction process requires close communication and collaboration within the project team and with other participants during the construction of the project [34]. Therefore, a harmonious team atmosphere is essential for the smooth delivery of GH projects. In theoretical research and practice, the factors of cooperation between teams are often neglected. However, the findings of this study suggest that the project team should enhance the trust between members and other participants through official or informal channels and establish a good cooperation atmosphere and mechanism to realise the sharing of information and raise the overall efficiency of the work. In addition, for the GH industry, the successful development of GH projects is a systematic process that requires the support of stakeholders at all stages [71]. In the development decision-making stage, owners with a sustainable philosophy and a sense of ethics make GH development decisions based on an understanding of the function of GH. During the construction phase, senior management provides material and information resources to the GH project team from the company level and the consultants and material suppliers work closely with the project team, which plays an important role in the successful construction of GH projects. Finally, end users also play an important role in the successful development of GH projects. Their opinions and suggestions can make the GH design human and efficient, which will help improve the performance of GH projects.

6. Conclusions

GH is distinguished from traditional housing in terms of design, management, materials, and processes. The development plans, complex design, and project management of GH are all huge challenges. In view of the smooth implementation and delivery of the project, this study identified 20 CSFs through literature review. The five important principal components identified through PCA were project management factors, personnel ability factors, teamwork-oriented factors, human resource factors, and financial and constraint factors. Multiple regression analysis was used to reveal that project management factors, personnel ability factors, and financial and constraint factors all have positive impact on the successful development of GH projects and evaluate the importance of CSFs for GH development. The project management factors have the greatest impact. This study identified the CSFs of GH development in China, which provided guidance and reference for enterprises to develop GH, enhance the government's incentive and regulatory behaviour, and improve the management of traditional housing project to achieve efficient delivery and development of GH.

Although this study is not exhaustive, it comprehensively reviews CSFs for GH projects. The results presented in this study have several important implications for GH practitioners and researchers. Theoretically, this study comprehensively reviews and analyses the previous studies on key success factors for GH projects, providing not only a systematic summary of previous achievements but also a theoretical basis for future research. On the basis of the findings of this study, researchers can further expand and analyse the CSF system for the delivery of GH projects and explore effective promotion mechanism for the successful development of GH projects. In practice, the current development of GH projects in China is not yet mature and faces many technical and management difficulties. The practitioner can take the CSFs proposed in this study as a checklist to guide the formation of a project team before the implementation of GH projects. During the construction of GH projects, project managers can formulate management measures for GH projects based on this checklist. These findings can also provide guidance for the government to formulate and implement incentive and regulatory strategies.

Although the objectives were achieved, limitations were identified. Firstly, the data from the questionnaire were influenced by the experience and attitude of the respondents. The questionnaire was subjective, and the sample size was small. These factors should be marked when interpreting the analysis results. Secondly, this study selected representative regions of China for investigation and was well explained in the Chinese context. However, this study lacked coverage, and the results may be different from other countries. Therefore, in future research, we can select GH-related cases from China and other countries for comparison and analysis and explore the CSFs of the project by finding common points and differences to achieve the successful development of GH globalization.

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 that there are no conflicts of interest regarding the publication of this paper.

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