Performance assessment and influencing factors of human settlement improvement in traditional villages based on Balanced Scorecard theory: a case study of Jiaozuo, China

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Assessing the performance level of human settlement improvement in traditional villages is significant in promoting the protection of traditional villages, but there is a lack of performance research on human settlement improvement from the perspective of corporate governance in previous studies. This paper selected 16 traditional villages as case villages and obtained a total of 345 questionnaires. By reference to the Balanced Scorecard (BSC) theory, a performance evaluation index system for human settlement improvement is constructed in this paper. In addition, the level of performance exhibited by traditional villages is evaluated and analyzed via the entropy weight Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method and the obstacle degree analysis method. This study reveals the following findings: (1) The performance level of traditional villages in Jiaozuo city ranges between 0.28 and 0.64, with an average value of 0.49, thus indicating a medium level. (2) With respect to the subdimensions of human settlement improvement performance, the policy management dimension (0.88) exhibits the highest value, followed by the villagers dimension (0.48) and the learning and growth dimension (0.27), while the financial benefits dimension (0.10) exhibits the lowest value. (3) The obstacles affecting the performance level of human settlement improvement in different types of traditional villages are characterized by both similarities and differences. This study summarized the effects of traditional village human settlement improvement, and provided more scientific and reliable governance suggestions for future traditional village human settlement improvement, so as to better promote the protection of traditional villages and the sustainable development of the human settlement environment.

KEYWORDS

traditional villages, Balanced Scorecard, human settlement improvement, performance evaluation, entropy weight TOPSIS

1 Introduction

The human settlement environment is formed through interactions between human society and the natural environment, which constitutes a dynamic and complex system (Zhu et al., 2022). Due to the rapid development of villages and the destruction of enclosed human settlements, problems related to human settlement improvement have begun to emerge (Tan et al., 2021). The development of the human settlement environment determines the quality of regional economic development and the ecological environment to a large extent, which is related to the fundamental well-being of the general population. In this realistic context, the question of how to protect and

govern the human environment systematically and effectively has received widespread attention. Some developed countries and regions, like Germany, Japan, and South Korea, have paid attention to the human settlement environment earlier than others and adopted unique models of human settlement development. In addition, the United Nations Human Settlements Program (UN-Habitat) was established to promote the development of human settlement in 2002. Since the establishment of this program, relevant actors have been working to improve the human settlement environment and promote the transformation of cities and human settlement (Beyene et al., 2023). These initiatives have caused the human settlement environment to attract more attention and also notably contributed to the development and improved quality of people's life (Stephen et al., 2002).

The concept of human settlement science was introduced by the Greek architect and urban planner Constantinos Apostolou Doxiadis in the 1950s (Liu et al., 2023). The earliest studies on human settlement were largely urban-oriented, and scholars working in this field researched land planning and urban settlement (Mugisha et al., 2024; Morse and Robinson, 2024). Numerous scholars have conducted research on the spatiotemporal evolution of the human settlement system (Qin et al., 2024; Yin et al., 2024), the characteristics of human settlements and their intrinsic mechanisms (Tang et al., 2017). Moreover, some scholars have commenced exploring the quality of human settlements (Zhang et al., 2024) and determining the quality of life in human settlements (Angela et al., 2021). Additionally, there have been many studies delving into the level of metabolism in human settlements (Rodríguez et al., 2023) and many other related topics (Ntlhe, 2022; Tian et al., 2023; Karina, 2021).

Until the 1970s, due to the gradual migration of urban residents in Europe and the United States to the suburbs (Yang et al., 2020), the focus of research on human settlements began to shift to rural areas (Hu and Wang, 2020). Many studies have emerged on rural human settlements patterns (Antonov and Safronov, 2024). Furthermore, the scope of this kind of research is more extensive. It includes studies on the socio-economic value of human settlements (Stănilă and Barbu, 2016) and the mechanism of the impact of human settlements (Ran et al., 2024). At the same time, emphasis has been placed on the quality of rural human settlements. The governance of environmental sanitation and the quality of human settlements have been explored (Liu et al., 2021). Some scholars have also begun to pay attention to the relationship between the livelihood issues of farming households and human settlements (Cui et al., 2022) and many other fields (Harris et al., 2017; Mpofu et al., 2018; Egidi et al., 2020; Kleemann et al., 2017). These previous studies have gradually encompassed traditional villages. The research content includes not only the study of the habitability and vulnerability of human settlements (Liu et al., 2016; Wang et al., 2023), but also the transformation and development of human settlements (Gao et al., 2024; Liu et al., 2023; Tang and Long, 2022). These existing studies have played a significant role in the development of human settlements in traditional villages (Gong et al., 2020). These previous studies have played a significant role in the development of traditional village human settlements.

However, the human settlement is constantly renewed and developed, featuring continuity and dynamism. Research on human settlement is also more diversified. But there are still many overlooked aspects in the existing research. Based on the existing research, this study innovates in research content and research methods. In terms of research content, most of the research on human settlement is about human settlement systems, human settlement governance, and other content. There is a lack of attention to the effect of human settlement improvement, and performance evaluation research on environmental

improvement is even rarer. The research on performance evaluation is a summary of the work of human settlement improvement, which has certain research value for improving the efficiency of human settlement improvement. Therefore, from the perspective of performance evaluation, the research content of this article conducts an evaluation study on human settlement improvement, summarizes the improvement effect of human settlement, and puts forward constructive suggestions for human settlement improvement. In terms of research methods, previous research on human settlement was mostly qualitative research, directly choosing methods such as villager satisfaction evaluation method, case analysis method, and literature analysis method for research (Ma et al., 2024; Zhang et al., 2024). However, this study is a quantitative research. It uses mathematical-statistical methods such as entropy weight TOPSIS to process a large amount of questionnaire data, reducing the influence of researchers' subjective factors. The method is more evidence-based for the determination of weights in the study. It can also accurately reflect the gap among the performance levels of traditional village human settlement improvement, which makes it easy to interpret and explain the results.

In addition, this paper also takes into account various aspects such as the financial benefits of human settlement improvement, the growth of villagers, and the later-stage environmental maintenance, etc. (Strijker et al., 2020). Therefore, this paper uses the Balanced scorecard theory to construct the performance evaluation index system. The Balanced Scorecard theory is a comprehensive strategic index evaluation system (Abedian et al., 2024), and some scholars have already used the Balanced Scorecard theory to construct index systems for research (Celestino and Silva, 2011; Nikolaou and Tsalis, 2013; Cho et al., 2015). Therefore, this paper is innovative in both research content and research methods. Combining the performance evaluation theory with the characteristics of human settlements for the construction of evaluation index system makes the research more comprehensive and scientific.

In this study, 16 traditional villages in Jiaozuo City, located in the northwestern part of Henan Province, were selected for the study. Using the Balanced Scorecard theory to construct an evaluation index system from four dimensions (villagers, policy management, economic benefits, and learning and growth), which is used to measure the performance index of habitat improvement in different traditional villages. We also analyze the relevant obstacles with the goal of determining the status of human settlement improvement in these traditional villages. The traditional villages selected in the paper have rich historical and cultural connotations, and the indicators of cultural environment are also added in the construction of the indicator system. This is consistent with previous studies that have emphasized the importance of the cultural environment of traditional villages. In summary, this paper not only enriches the research on human settlements, but also promotes the protection of traditional villages and the sustainable development of human settlements. It has certain practical and theoretical significance for the international community.

2 Data and methods

2.1 Study area and data sources

Jiaozuo city is located in the northwestern part of Henan Province, China. The city has a favorable geographical location with a total area of 4,071 km². It borders the Taihang Mountains in the north and the

Yellow River in the south, and the corresponding terrain is low in the south and high in the north. Jiaozuo City has a long history and culture, so it has a large number of traditional villages. Owing to its distinctive topography, climate and hydrological environment, coupled with its long history, Jiaozuo City has preserved numerous traditional villages. Up to now, there are 58 traditional villages in Jiaozuo City. In recent years, the government of Jiaozuo city has actively responded to the national policy on human settlement improvement by paying a great deal of attention to the work of human settlement improvement. The city has thus been awarded the title of "Advanced City of the Province in the Three-Year Action of Rural Human Settlement Improvement." Therefore, research on the performance of human settlement improvement in traditional villages in Jiaozuo city is both enlightening and representative.

The data utilized for the study presented in this paper are derived from field surveys. These data were obtained through questionnaires and semi-structured interviews conducted in the selected villages. The process of obtaining the data involved a preliminary inspection of the traditional villages in Jiaozuo city in July 2023. The selection of the sample villages in Jiaozuo city is based on their geographic location, economic level, and the type of development characteristic of traditional villages. Ultimately, 16 traditional villages in Jiaozuo City are identified as sample villages through the stratified sampling method (Figure 1).

From July 20 to 31 in 2023, interviews and questionnaires were designed based on a pre-survey. The questionnaires were revised and improved on the basis of feedback received during the research process, thereby generating the final questionnaire. From August 1 to 12, the main research was conducted in the selected sample villages. According to the actual number of people, a random sampling method was used to select villagers, who were randomized in terms of gender, age, economic income, literacy level, and length of residence. The required data were obtained by conducting a questionnaire survey among these villagers and conducting semi-structured interviews with village committee staff and village leaders (Table 1). A total of 368

questionnaires were distributed, and 345 valid questionnaires were collected, for an effective recovery rate of 93.7%.

2.2 Evaluation indicator system

The Balanced Scorecard, which originated in the 1990s, is a system of metrics used to evaluate business performance that was proposed by American manager Norton and Harvard professor Kaplan (Chaharlang et al., 2023). The scorecard includes four dimensions, namely, customers, internal management, finance, and learning and growth (Rasoolimanesh et al., 2015). Essentially, the Balanced Scorecard focuses on establishing a balance between financial and non-financial goals as well as between short-term and long-term goals. This theory is widely applied not only in the economic field. Domestic scholars have applied it to research such as the evaluation of new-type city construction and the performance evaluation of ecological and cultural tourism construction. Traditional rural human settlement improvement involves establishing a balance between financial and non-financial aspects, between the improvement situation and environmental sustainability, and between the improvement process and results. This coincides with the concept of applying the Balanced Scorecard method. Therefore, it is feasible to apply the Balanced Scorecard theory to the development of the performance evaluation system for the improvement of the human settlement in traditional villages. Balance Then focus on four aspects of "villagers, management, economy and development" to adjust the framework of the Balanced Scorecard theory (Liu et al., 2022). Eventually, an evaluation index system is formed from four dimensions: villagers, policy management, financial benefits, and learning and growth, as shown in Figure 2. Then data collection and processing are carried out, and an empirical study is conducted on 16 traditional villages to analyze the performance level of the renovation of the human settlement in traditional villages.
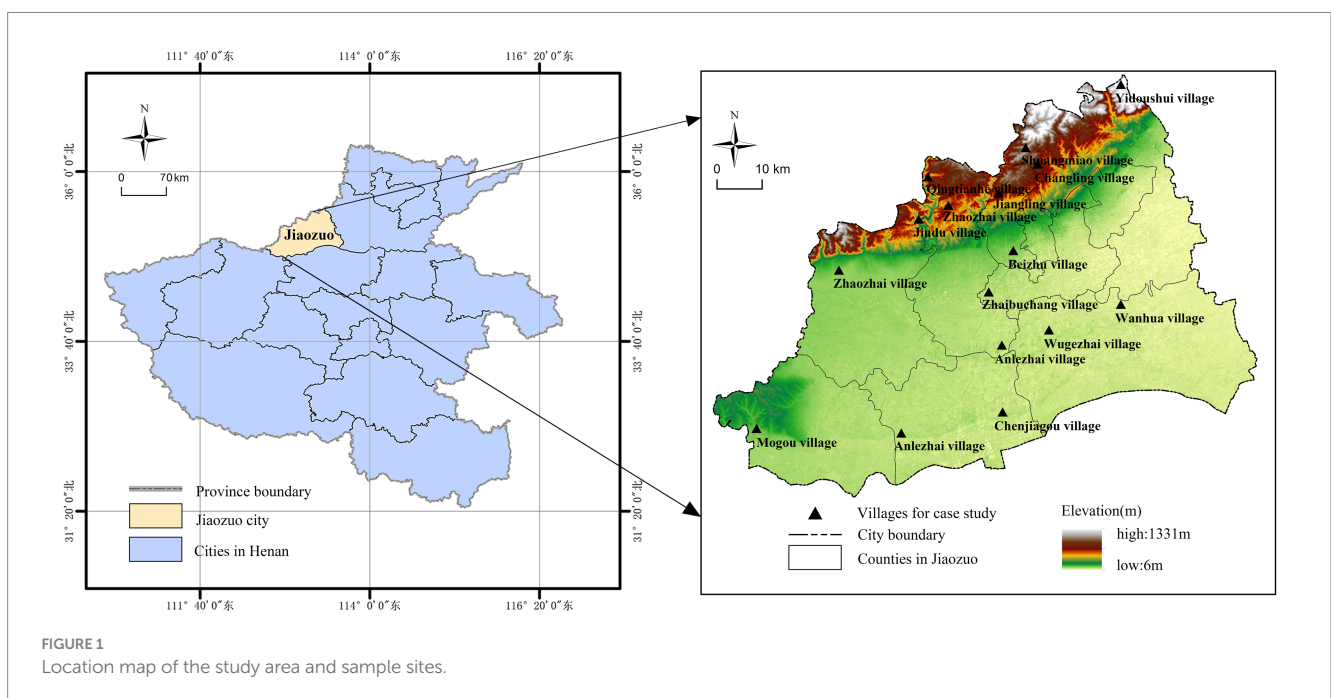

FIGURE 1
Location map of the study area and sample sites.

TABLE 1 Study area and sample size.

Rank	Survey counties	Survey villages	Topographic features	Sample size
National-level	Zhongzhan	Beizhu	Plain and hill	24
	Xiuwu	Shuangmiao	Plain, mountain, and hill	19
		Yidoushui	Mountain	26
		Changling	Mountain	16
	Qinyang	Jiudu	Mountain and hill	22
	Wenxian	Chenjiagou	Plain and hill	27
	Mengzhou	Mogou	Plain and hill	23
	Shanyang	Zhaibuchang	Plain and hill	25
	Boai	Wugezhai	Plain and hill	22
Province-level	Xiuwu	Wanhua	Plain	26
		Xiaodong	Plain	21
	Wenxian	Anlezhai	Plain and hill	24
	Boai	Qingtianhe	Mountain	19
		Jiangling	Mountain and hill	23
	Qinyang	Zhaozhai	Plain	27
	Zhongzhan	Shierhui	Mountain	24

The Balanced Scorecard can systematically describe, measure and manage strategic objectives. In this paper, the Balanced Scorecard is applied to the study. First of all, it should be clear that the study aims at promoting the conservation of traditional villages and sustainable environmental development. In order to introduce the BSC into human settlement research, a performance evaluation index system is constructed with the four dimensions of villagers, policy management, financial benefits and learning and growth as the main content. The performance level of human settlement improvement is analyzed based on the results obtained from this study. Ultimately, strategies for better environmental management are proposed to better promote the protection of traditional villages and the sustainable development of the human settlement (Figure 3).

The villagers dimension replaces the original customer dimension. People rely on human settlements for production and life (Li et al., 2022). Accordingly, villagers are the direct beneficiaries of human settlement improvement, and they have the most intuitive feelings regarding the state of the human settlement. Therefore, the degree of villagers' understanding and participation in environmental improvement as well as their degree of satisfaction with environmental improvement can most accurately reflect the performance of environmental improvement in traditional villages (Wang et al., 2021). Finally, three indicators are selected with regard to the villager dimension: the degree to which villagers recognize human settlement improvement, the degree to which villagers participate in human settlement improvement, and the degree to which villagers' satisfaction with human settlement improvement.

The selection basis of policy management dimension indicators includes two aspects: policy support and management behavior. In the process of rural human settlement improvement, policies related to rural human settlement improvement play an important supporting role in environmental improvement work. In addition, strict

management and supervision of the improvement work have a huge impact on the performance of rural human settlement (Wang et al., 2017). Therefore, in the policy management dimension, the number of policies and regulations related to rural human settlement improvement is selected as an indicator to represent the degree of policy support. The implementation efficiency of rural human settlement improvement and the number of post-improvement monitoring and evaluations are selected as two indicators to represent the management behavior in the process of rural human settlement improvement.

The selection of indicators in the financial benefit dimension takes into account two aspects: capital investment and renovation effects. In enterprise management, the financial benefit dimension refers to financial input and output in enterprise performance evaluation. However, this article focuses on the performance evaluation of the human settlement environment renovation in traditional villages. It is necessary to consider the capital investment in the human settlement environment renovation and the environmental situation after the renovation. It can directly reflect the performance of the human settlement renovation in traditional villages. With respect to financial input, two indicators are selected, namely, the amount of funds earmarked for human settlement improvement and the utilization of funds for human settlement improvement. The selection of indicators for governance is extensive. It pertains not only to infrastructure, public service facilities, living conditions (Li et al., 2018), and the level of economic development. It also takes into account factors that represent the cultural environment of traditional villages. Traditional villages have deep historical and cultural heritage, unique architectural features, and traditional customs. Therefore, five indicators are selected on the basis of rural human settlement, namely, the percentage of vegetation cover, water quality status, population resident rate, infrastructure status, and public service facilities. Furthermore, four indicators that can reflect the cultural connotations of traditional villages are added to this list to symbolize the cultural environment of traditional villages. These factors include the abundance of folklore activities, the degree of handcrafted skill transmission, the renovation status of traditional buildings, and the coherence of the overall appearance of the historical environment.

The learning and growth dimension reflects the progress of village committees and villagers in the process of learning relevant knowledge and using relevant technical equipment in the context of human settlement improvement. These factors can reflect the degree of subsequent sustainable development in the human settlement and the degree of importance attached by village committees and villagers to the task of improving the human settlement. Therefore, the learning and growth dimension consists of two aspects, namely, skills upgrades and promotional communication. Three indicators are selected for skills upgrades, namely, technological innovation and application, the number of technicians recruited, and the number of knowledge training sessions conducted. In contrast, two indicators are selected for promotional communication, namely, the number of popular human settlement improvement campaigns and the number of instances of exchange and cooperation between villages and the outside world. These indicators are highly important with regard to the long-term maintenance of the results of human settlement improvement and have significant impacts on the evaluation of human settlement improvement performance.

In summary, according to the performance evaluation framework for traditional village human settlement improvement constructed above and corresponding field research, a performance evaluation

FIGURE 2
Modification of the Balanced Scorecard framework for performance evaluation of traditional village human settlement improvement.

FIGURE 3
The cyclic process of introducing BSC to evaluate traditional village human settlement improvement.
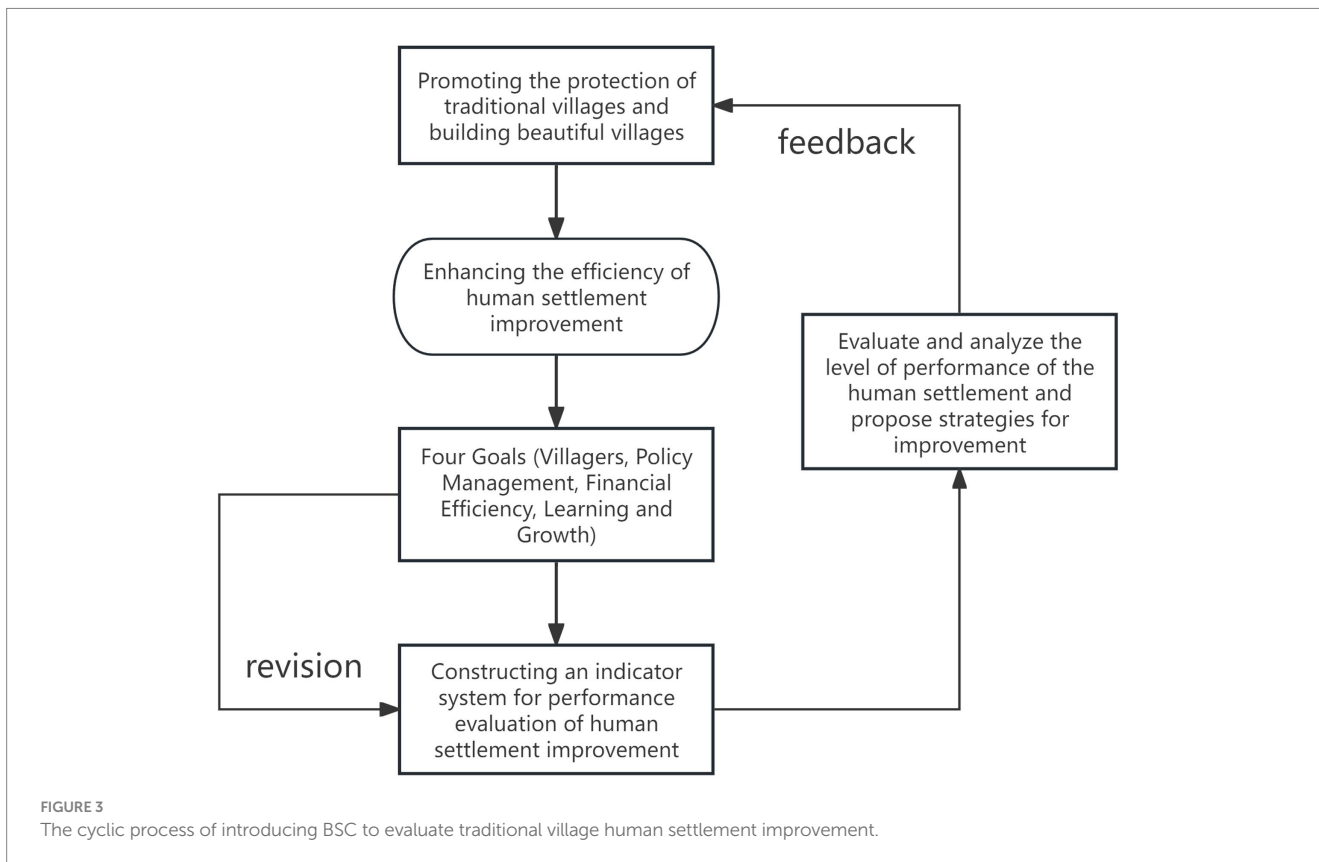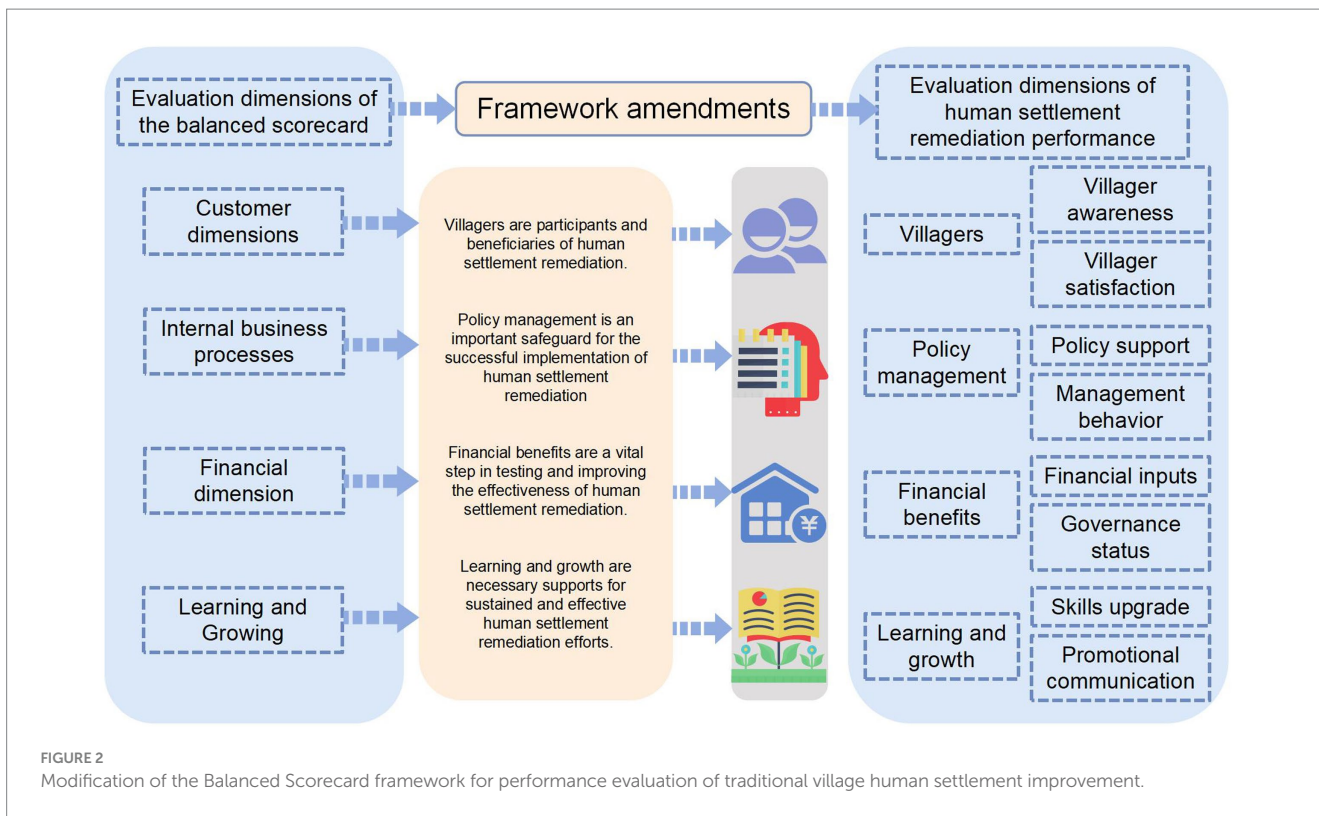
index system for human settlement improvement is constructed in accordance with the principles of scientificity, operability, and referability (Table 2). A total of 22 specific indicators representing the four dimensions of villagers, policy management, financial benefits, and learning and growth, are selected for the evaluation indicator system.

2.3 Methodology specification

2.3.1 The entropy weight TOPSIS method

Use the entropy weight TOPSIS method to evaluate and rank the performance level of the human settlement improvement in traditional villages (Sun and Wang, 2022). First, weight the indicators through the entropy weight method. Then, calculate the weighted distances between each evaluation object and the positive-ideal solution and the negative-ideal solution, thereby determining their superiority-inferiority order. Conducting quantitative research with the entropy weight TOPSIS method and processing a large amount of data determines weights and evaluation results have clear bases. This avoids the influence of researchers' subjective factors and makes the research more universal and scientific. Moreover, many scholars have already used this method in existing research. For example, Jing et al. used this method to evaluate the value of the ancient vernacular dwellings in traditional villages (Jing et al., 2021) used this method to study the protection and renewal strategies of traditional villages (Zhao and Zhang, 2023). To determine the indicator weights using the entropy-weighted TOPSIS method, first, the data should be made dimensionless to eliminate the influence of the magnitude differences between indicators on weight determination. After standardizing the data, calculate the proportion of each indicator value, as well as its entropy value and utility value, and finally use the utility value to determine the objective weights of the indicators. After determining the weights, use the TOPSIS method to rank each evaluation object. The specific calculation steps are as follows:

Step 1: Construct the normalization matrix.

$$Y_{ij} = \left(X_{ij} - X_{jmin} \right) / \left(X_{jmax} - X_{jmin} \right)$$

where Y_{ij} is the standardized value of the jth indicator in the ith traditional village, X_{ij} is the original value of the indicator, $X_j$min is the minimum value of the indicator, and $X_j$max is the maximum value of the indicator.

Step 2: Calculate the weight of each indicator value.

$$P_{ij} = Y_{ij} / \sum_{i=1}^{m} Y_{ij}$$

where m is the number of evaluation subjects.

Step 3: Calculate the entropy value e and the utility value g for each indicator.

$$e_j = -k \sum_{i=1}^{m} P_{ij} \ln P_{ij}; g_j = 1 - e_j$$

Step 4: Determine the indicator weights W.

$$W_j = g_j / \sum_{j=1}^{n} g_j$$

where n is the number of indicators.

Step 5: Construct the weighted normalization matrix.

$$Z = Y \times W$$

Step 6: Determine the positive ideal solution $Z+$ and the negative ideal solution $Z-$.

$$Z_i^+ = \left\{ maxZ_{ij} | j = 1,2,\ldots,m \right\}; Z_i^- = \left\{ minZ_{ij} | j = 1,2,\ldots,m \right\}$$

Step 7: Calculate the distance of each evaluation object from the positive and negative ideal solutions.

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(Z_{ij} - Z_j^+ \right)^2}; D_i^- = \sqrt{\sum_{j=1}^{n} \left(Z_{ij} - Z_j^- \right)^2}$$

Step 8: Calculate the relative proximity C_i of each evaluation object to the optimal solution.

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-}$$

where C_i represents the performance index of traditional village human settlement improvement, the value interval is [0, 1]. The larger the value indicates that the performance level of human settlement improvement is higher, and vice versa is lower.

2.3.2 The obstacle degree analysis method

To further identify the main obstacle factors affecting the level of performance of human settlement improvement, the obstacle degree model was applied to calculate the impact of each indicator on the performance of human settlement improvement (Yang et al., 2021). The calculation formula is as follows:

$$I_j = \left(1 - Y_{ij} \right) G_j / \sum_{j=1}^{i} P_{ij} G_j \times 100\%$$

where $i = 22$; P_{ij} represents the indicator deviation, indicating the gap between a single indicator and the optimal target value; I_j represents the obstacle degree, indicating the degree to which the jth indicator is an obstacle to the improvement performance; and G_j represents the factor contribution, indicating the degree to which the jth indicator influences the performance of environmental improvement.

3 Results

3.1 The performance level of human settlement improvement in traditional villages

On the basis of the preceding discussion, the entropy weight TOPSIS method is used to calculate the comprehensive values of the performance level of 16 traditional villages in Jiaozuo city. Figure 4 ranks the human settlement improvement performance ratings from highest to lowest.

TABLE 2 Performance evaluation indicator system for human settlement improvement.

Target layer	Standardized layer	Factor layer	Indicator layer	Weight
A human settlement improvement performance	B1Villagers	C1Recognition by villagers	D1the degree to which villagers recognize human settlement improvement	0.031
		C2Participation of villagers	D2the degree to which villagers participate in human settlement improvement	0.075
		C3Satisfaction of villagers	D3the degree to which villagers satisfaction with human settlement improvement	0.023
	B2Policy management	C4Policy support	D4the number of policies and regulations pertaining to the human settlement improvement program	0.054
		C5Management behaviors	D5the efficiency of the implementation of human settlement improvement	0.022
			D6the number of post-improvement monitoring assessments	0.037
	B3Financial benefits	C6Financial inputs	D7the amount of funds earmarked for human settlement improvement	0.067
			D8the utilization of funds for human settlement improvement	0.020
		C7Governance status	D9the percentage of vegetation cover	0.042
			D10water quality status	0.040
			D11population resident rate	0.044
			D12the abundance of folklore activities	0.068
			D13the degree of handcrafted skill transmission	0.085
			D14the renovation status of traditional buildings	0.042
			D15the coherence of the overall appearance of the historical environment	0.035
			D16infrastructure status	0.022
			D17public service facilities	0.050
	B4The learning and growth dimension	C8Skills upgrades	D18technological innovation and application	0.045
			D19the number of technicians recruited	0.051
			D20the number of knowledge training sessions conducted of human settlement	0.058
		C9Promotional communication	D21the number of popular human settlement improvement campaigns	0.065
			D22the number of instances of exchange and cooperation between villages and the outside world	0.024

Figure 5 shows the level of human settlement improvement performance in traditional villages and the spatial spread of their ranks. The results reveal that the average level of human settlement improvement performance in the context of traditional villages in Jiaozuo city is 0.49, while the median value is 0.52, thus indicating that human settlement improvement performance in the context of traditional villages in Jiaozuo city is at a medium level overall, although the majority of traditional villages exhibit a high level of improvement performance. The performance level of traditional villages is further divided into three categories based on a cluster analysis conducted with the assistance of SPSS software: high improvement performance level (0.57 ~ 0.64), medium improvement performance level (0.38 ~ 0.56), and low improvement performance level (0.28 ~ 0.37). Traditional villages that exhibit high, medium, and low levels of performance in terms of human settlement improvement account for 31.25, 37.5, and 31.25% of the sample, respectively.

Recalling the above and Figure 4, the level of performance of human settlements in traditional villages has been categorized. There are five traditional villages with high remediation performance, in descending order as follows: Shi'erhui Village (0.64), Mogou Village (0.62), Wanhua Village (0.61), Shuangmiao Village (0.60) and

Chenjiagou Village (0.60). All villages of this type are tourist-oriented traditional villages that feature high levels of transportation access, good tourism development, and good economic conditions. Six traditional villages feature medium improvement performance levels, which are listed in descending order as follows: Zhaozhai village (0.56), Jiangling village (0.53), Zhaibuchang village (0.52), Anlezhai village (0.51), Yidoushui village (0.48), and Qingtianhe village (0.43). Five traditional villages feature low improvement performance levels, which are listed in descending order as follows: Beizhu village (0.37), Wugezhai village (0.37), Xiaodong village (0.34), Jiudu village (0.33), and Changling village (0.28). This type of village is characterized by a weak economic base, a low level of government attention, and a weak sense of villager participation.

3.2 Four dimensions of human settlement improvement performance levels

Figure 6 shows the performance level of human settlement improvement in different dimensions of traditional villages. The results regarding the four dimensions of human settlement

improvement performance are 0.88 for the policy management dimension, 0.48 for the villagers dimension, 0.27 for the learning and growth dimension, and 0.10 for the financial benefits dimension. The research results show that the performance level of the policy management dimension in improving the human settlement environment is the highest. Most traditional villages place a high emphasis on improving the human settlement environment, and the management work related to environmental improvement is well-organized, with staff showing a responsible and dedicated attitude. The second-highest dimension is the villagers' involvement, as most traditional villages have improved the village environment and enhanced residents' quality of life after carrying out the human settlement environment improvement, with villagers expressing a high level of satisfaction with the work. The third dimension is learning and growth. In many traditional villages, during the environmental improvement process, the importance of technological innovation and talent utilization is often overlooked. Moreover, there is a lack of knowledge and learning about environmental improvement, leading to insufficient endogenous motivation in the villages. The lowest performance level is in the financial benefits dimension, which highlights issues such as the insufficient funds for environmental improvement in traditional villages.

3.3 The obstacles affecting the level of performance in human settlement improvement

On the basis of the results of our analysis of the performance of different traditional villages, we use the obstacle degree model to explore the factors affecting the performance level of human settlement improvement in depth by obtaining the obstacle degree value for each single indicator across the three types of traditional villages. After these obstacle degree values are organized from high to low, the five most highly ranked obstacles pertaining to each traditional village are identified as the main obstacles that affect the performance of these various traditional villages in the context of human settlement improvement. The main factors influencing the evaluation of the performance of traditional villages in human settlement improvement are then analyzed (Table 3). The results reveal that the obstacles affecting the performance of each type of human settlement improvement are not identical and highlight three common obstacle factors, namely, the degree to which handicrafts are inherited (D13), the degree to which villagers participate in human settlement improvement (D2), and the number of times human settlement improvement publicity is popularized (D21). However, the degrees to which obstacles affect each type of performance differ.
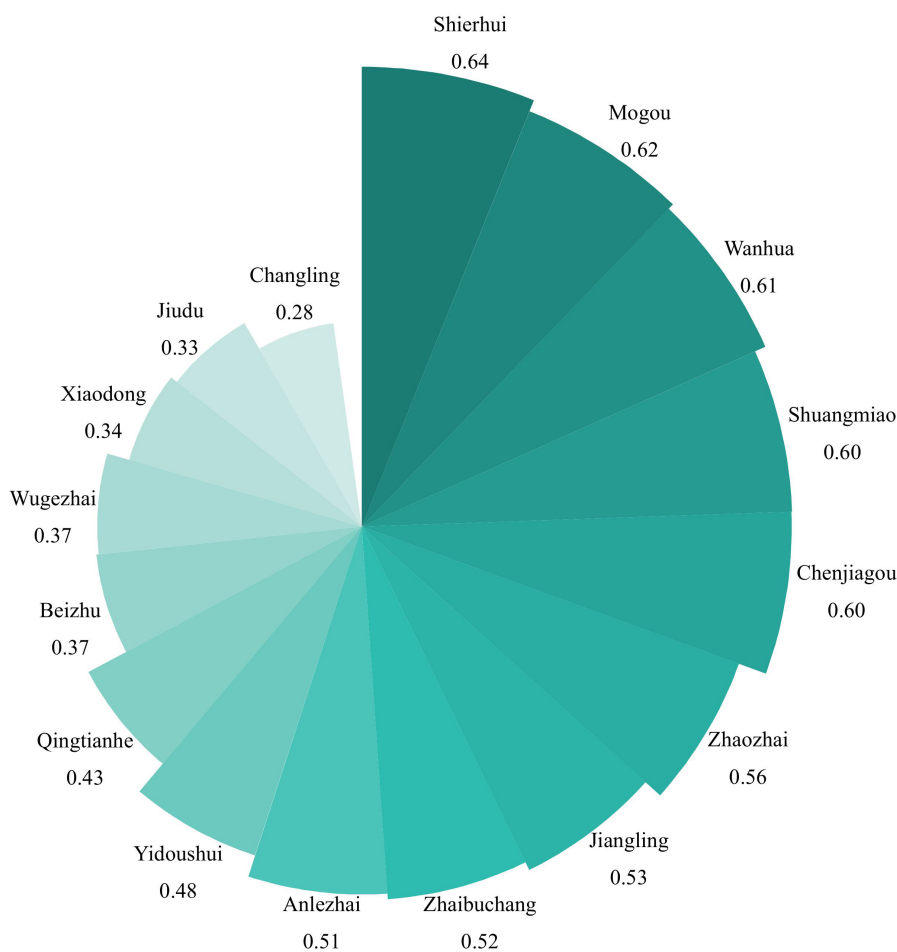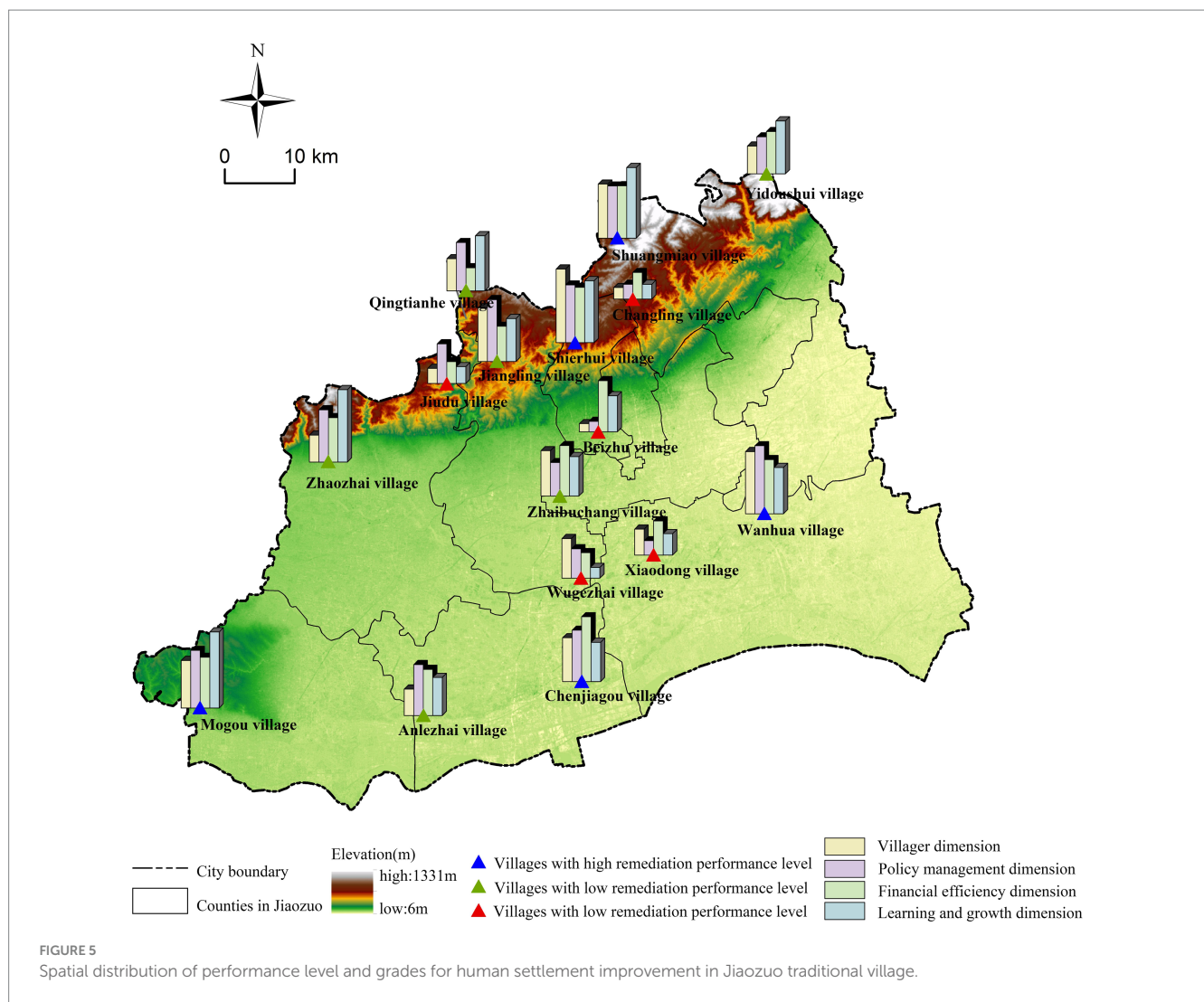
FIGURE 5
Spatial distribution of performance level and grades for human settlement improvement in Jiaozuo traditional village.

4 Discussion

4.1 Analysis of the results of human settlement improvement in traditional villages

According to the field survey, it is found that traditional villages with outstanding improvement performance are all tourist-oriented. In these villages, the economic development is relatively better, and villagers' quality of life is higher. The excellent development of tourism in these villages drives the economic growth of the villages and provides favorable economic conditions to support the improvement of human settlements in the villages (Ma and Tang, 2023). Moreover, tourism development has prompted village committees and villagers to pay more attention to human settlement development. The village committees have strengthened the publicity of human settlement governance, and the villagers have paid attention to the task of protecting human settlements in their daily lives. In addition, the village committees of traditional villages with high remediation performance levels have village rules and regulations to prevent villagers from destroying the environment and to motivate villagers to improve the environment (Zhang et al., 2024). For example, during the

"Patriotic Hygiene Activity Month," the village committee leads villagers in the cleaning process to ensure high participation of villagers and enable them to take better care of the hygienic environment in the village. In general, traditional villages that feature a high level of improvement performance benefit from good tourism development, effective management policies, and the extensive participation of villagers in environmental improvement (Cheng et al., 2024).

Traditional villages with a medium level of improvement performance have several issues that reduce their level of human settlement improvement performance (Zhou et al., 2021). According to the field survey combined with the spatial and temporal distribution map in Figure 5, Zhaozhai village, Zhaibuchang village, and Anlezhai village are located in the plains. They have a high degree of road accessibility, making the transportation of installations required for environmental improvement more convenient. However, the development of industries in these villages is relatively limited, and the traditional cultural heritage is relatively weak, which has a certain degree of impact on the improvement of their cultural environment. Jiangling village, Yidoushui village, and Qingtianhe village rely on the Taihang Mountains for their tourism, which can promote better economic conditions, and village committees pay more attention to the governance of human settlements. However, due to their geographical location, the natural environment of these villages is susceptible to damage by bad
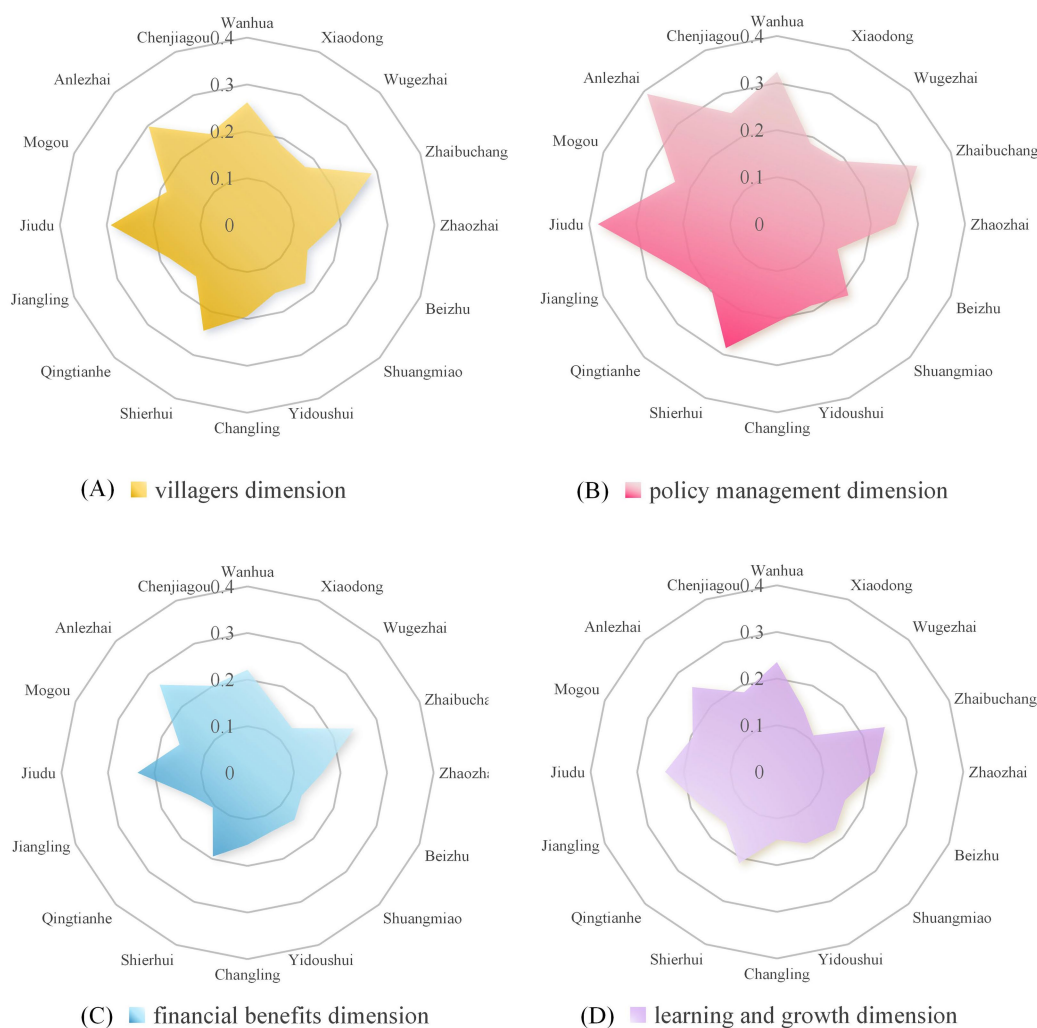
FIGURE 6
Performance level of human settlement improvement of traditional villages in villagers, policy management, financial benefits, and learning and growth dimensions.

weather (Wu et al., 2023). In addition, the lack of management of tourists has led to the random disposal of garbage by tourists, which has reduced the level of performance in improving the habitat of the village. In summary, traditional villages with a medium level of human settlement improvement performance are faced with problems such as a weak cultural heritage, incomplete village infrastructure construction, and inadequate management of tourists by village committees.

According to the field survey, traditional villages with low levels of remediation performance have more problems, and the causes are complex. Among these villages, Beizhu village, Wugezhai village, and Xiaodong village are located in the plains and feature a weak cultural heritage, limited industry, and poor economic conditions. Moreover, the government pays relatively less attention to human settlement improvement. The work on human settlement improvement by village committees is unsatisfactory. Simultaneously, villagers in traditional villages featuring low levels of settlement performance rarely participate in human settlement improvement activities and are more dissatisfied with the results of human settlement improvement. Jiudu and Changling villages are located in the Taihang Mountain ravine to the west of Jiaozuo, which is characterized by surrounding mountains,

inconvenient access and transportation, and obstacles to the transportation of human settlement improvement equipment in the villages (Cui et al., 2022; Wang and Zhu, 2023). In summary, traditional villages that feature a low level of improvement performance are the result of a combination of poor economic conditions (Stănilă and Barbu, 2016), obstacles to transportation, inefficient village committees, and a weak sense of participation on the part of villagers.

4.2 Analysis of performance level of human settlement by four dimensions

The policy management dimension is ranked highest among the four dimensions of human settlement improvement performance. A well-founded system of policies and effective management can provide important support for villages that exhibit medium and high levels of improvement performance (Beyene et al., 2023), thus enabling them to implement effective and long-term human settlement improvement. Reasonable village rules and effective management not only prevent villagers from destroying human settlements but also stimulate their

TABLE 3 Main obstacle factors for traditional village human settlement improvement performance indicators.

Typology	Form	Order of obstacles				
		1	2	3	4	5
High level of performance	Barrier Factors	D13	D20	D12	D21	D2
	handicap	16.871	9.757	8.553	7.402	6.619
Medium level of performance	Barrier Factors	D13	D2	D12	D14	D21
	handicap	14.953	12.546	10.908	5.729	5.402
Low level of performance	Barrier Factors	D2	D13	D21	D7	D20
	handicap	8.800	8.538	7.959	7.819	6.992

enthusiasm regarding the possibility of participating in human settlement improvement and making improvements in terms of governance efficiency and quality (Liu et al., 2024). In traditional villages that exhibit medium and high levels of improvement performance, the basic government can coordinate all parties, which can not only interact with higher levels of government and promote a fit between the will of that higher-level government and the democratic decisions made at the village level but also take responsibility for implementing policies and maintaining the operation of facilities at the grassroots level. This approach can also mobilize villagers to participate in environmental improvement and establish a good governance environment with a focus on "government management and village participation." In villages that exhibit low levels of improvement performance, the absence of a government management role leads to poorer results in terms of the improvement of the human settlement.

The villagers dimension is ranked second highest among these subdimensions. The enthusiasm of villagers regarding the possibility of participating in environmental management is an important foundation for the implementation of a long-term mechanism for rural environmental management. As "masters" of the village, villagers are not only participants in environmental governance but also beneficiaries of the results of environmental protection (Stephen et al., 2002; Liu et al., 2015). Therefore, the depth of villagers' participation in human settlement improvement is a key factor that impacts the villages' level of improvement performance. According to the survey, 70% of the villagers have a high degree of understanding of human settlement improvement and are very supportive of human settlement improvement in their villages. Among them, a small number of villagers actively participate in the improvement of the human settlement and contribute their efforts to the improvement of the human settlement. In addition, most villagers believe that human settlement improvement has improved the living environment and living conditions, and are very satisfied with the results of environmental improvement. These have largely improved the performance level of traditional village human settlement improvement. Only a very small number of villagers are dissatisfied with the results of human settlement improvement (Wang et al., 2021). The reason is that the villagers are dissatisfied due to the inaction of the village committee or the poor quality of the materials and supplies used in the environmental improvement process.

The learning and growth dimension is ranked third among these subdimensions. According to Figure 6D and the field survey, a few traditional villages have high performance levels in the learning growth dimension. On the one hand, these traditional villages actively publicize human settlement improvement and help villagers learn about human settlement improvement. On the other hand, they

actively employ technical personnel related to human settlement and update equipment for human settlement. These actions have greatly improved the efficiency and effectiveness of human settlement improvement (Wang and Zhu, 2023). The majority of villages have neglected the introduction and use of technicians and technical equipment for human settlement improvement. The lack of professionals for scientific and systematic human settlement improvement in traditional villages leads to the result of low efficiency of human settlement improvement. The lack of technology and equipment required for the improvement of human settlement also leads to insufficient endogenous motivation for the environmental improvement in villages (Angela et al., 2021). In this case, it is difficult to improve the performance level of human settlement improvement.

Among these sub-dimensions, the financial benefits dimension was ranked the lowest. In the process of human settlement improvement work, financial investment and equipment allocation are important factors that affect human settlement improvement performance. According to Figure 6C and the field survey, the level of performance of traditional village human settlements in terms of financial benefits is generally low. Among them, some traditional villages indicated that the amount of government funds allocated specifically for their environmental improvement was low. There is no economic support for them to carry out human settlement improvement. The activities of cultural awareness-raising and the renovation of traditional buildings are also difficult to carry out due to funding problems, resulting in poor preservation of the historic environment and landscape. In addition to this, most of the traditional villages indicated that their own industrial development was weak and their level of economic development was relatively low. Thus, it is difficult for the traditional villages themselves to access the funds required to improve the human environment. This issue makes it difficult for these villages to continue to improve the human environment when the amount of funds allocated by the government for this purpose is insufficient (Li et al., 2019; Lin et al., 2023). In summary, low levels of capital investment greatly reduce human settlement improvement performance in traditional villages.

4.3 Analysis of obstacles affecting the level of performance in human settlement improvement

The most notable public barrier with regard to the three types of villages is the degree of handcrafted skill transmission (D13). Among the sample villages selected for this study, 70% of the

traditional villages do not sell specialty products related to village culture. In addition, only a few traditional villages are home to inheritors of the village's intangible cultural heritage, which is a very unfavorable situation with regard to the protection of the cultural environment of traditional villages. The second public barrier in this context pertains to the degree to which villagers participate in human settlement improvement (D2). The number of times villagers participate in human settlement improvement reflects, to a certain extent, the villagers' attitudes toward human settlement improvement, which in turn has a strong effect on human settlement improvement performance (Cui et al., 2022; Wang and Zhu, 2023). According to the field survey, it was found that most of the villagers had low motivation to participate in the improvement of the human environment. As a result, human settlement improvement can only rely on the management of village committees and lacks bottom-up endogenous motivation. This has a significant impact on the level of performance in human settlement improvement (Wang et al., 2021). The third public obstacle in this context is the number of popular human settlement improvement campaigns (D21). In the sample villages selected for this study, most traditional villages ignored the importance of villagers and rarely called on villagers to participate in human settlement improvement (Lin et al., 2023). This situation is not conducive to human settlement improvement on the part of the entire population and, to a certain extent, reduces human settlement improvement performance.

In addition to such public obstacles, the most notable obstacle to high human settlement improvement performance is the number of knowledge training sessions conducted of human settlement improvement (D20). According to the field survey, it was found that traditional villages with a high level of settlement improvement performance did not pay enough attention to the training and learning of human settlement improvement knowledge. The lack of knowledge training for villagers has led to an insufficient knowledge base for villagers to participate in human settlement improvement. This situation is not conducive to their subsequent scientific and effective participation in human settlement improvement and greatly reduces the performance of human settlement improvement. The most notable obstacle in the context of medium human settlement improvement performance is the abundance of folklore activities (D12). According to the field survey, traditional villages at the medium level of improvement performance seldom organize folklore festivals, and there is less promotion of folklore culture. Some traditional villages only organize folk activities during the Spring Festival. This phenomenon greatly reduces the vitality of traditional villages and is not conducive to the sustainable development of the human environment (Zhao and Long, 2020). The most notable obstacle in the context of low human settlement improvement performance is the amount of funds earmarked for human settlement improvement (D7). According to the field research, traditional villages that are characterized by a low level of improvement performance exhibit relatively weak economic development. The amount of government funding provided for the improvement of human settlements in traditional villages is very limited, which makes it difficult to support the comprehensive improvement of human settlements in traditional villages.

4.4 Policy recommendations

According to the above conclusions, the following suggestions are proposed to improve the performance of human settlement improvement, starting from the different performance levels of traditional villages and their specific obstacle factors. Traditional villages with high improvement performance generally have a higher economic level, with the industrial economy mainly focused on tourism development. Therefore, in the subsequent work of this type of traditional villages, more attention should be paid to the planning and management of village tourism development, so as to maintain the development advantages of traditional villages. In addition, based on the obstacle factors, it is clear that the improvement of their human settlement performance is limited by difficulties in inheriting traditional handicrafts and the insufficient knowledge of villagers regarding human settlement improvement. Therefore, for traditional villages with high improvement performance, it is recommended to actively promote the cultural development of the village, and encourage villagers to learn traditional handicrafts to enhance the inheritance of these crafts (Liu et al., 2022). Moreover, training programs should be provided to villagers on improving their living environment. Enriching and strengthening the villagers' knowledge base on human settlement improvement will ensure that they can participate more effectively and scientifically in the work of improving human settlements (Wang et al., 2021).

Traditional villages with medium improvement performance, although they develop tourism, face less-than-ideal tourism development due to weak cultural heritage and poor management by the village committee. According to the obstacle factors, the performance of this type of traditional village's human settlement improvement is also limited by the inheritance of manual skills and the lack of folk activities. For this type of traditional village, it is recommended that the village committee implement grid management for the renovation of the human settlement environment, assigning specific responsibilities for different areas of improvement to enhance the efficiency of the renovation work (Wang et al., 2021). At the same time, efforts should be made to promote the village's traditional culture, actively organize various temple fairs, and increase the variety and number of traditional folk festivals. Constantly enriching the content of cultural development in the village will help enhance its attractiveness, foster the development of the village tourism industry, and positively guide the improvement of the human settlement environment.

Traditional villages with low improvement performance generally suffer from low visibility and low participation of villagers in the improvement of human settlement environments. Moreover, according to the obstacle factors, the low visibility of these villages makes it difficult for them to secure financial subsidies for human settlement improvement, which significantly impacts their ability to carry out such improvements. In view of this type of traditional villages, it is recommended to strengthen publicity and popularize human settlement improvement through comprehensive, multi-channel, and multi-faceted approaches. Not only should the visibility of the village be improved, but efforts should also be made to secure government financial subsidies for human settlement improvement. In addition, traditional villages should use the funds they receive for

human settlement improvement in a rational manner, ensuring that the funds are fully allocated to renovation work. It is also necessary to improve villagers' understanding of and participation in human settlement improvement, encouraging them to pay more attention to the protection of their living environment in their daily lives (Ye et al., 2022).

5 Conclusion

We conducted a study of the city of Jiaozuo, China, which is a city with many national-level traditional villages. We obtained the data through field surveys and used a series of mathematical statistical methods to calculate the data obtained. The results of the performance level of traditional villages in Jiaozuo City were finally obtained. We also analyze the obstacles affecting the performance level of traditional villages in human settlement improvement, so as to better improve the protection of traditional villages and promote the sustainable development of human settlement. The main findings of this study are summarized below.

(1) Levels of human settlement improvement performance in traditional villages in Jiaozuo city range from 0.28 to 0.64, with an overall average value of 0.49, thus indicating a medium level. Levels of human settlement improvement performance among the 16 traditional villages on which this research focused can be divided into three types, namely, high, medium, and low levels of settlement improvement performance, by using the cluster analysis method. In this context, traditional villages that exhibit high levels of improvement performance benefit from their high-level development of the tourism industry, their effective management policies, and the presence of villagers who are deeply involved in the process of environmental improvement. Traditional villages that exhibit medium levels of human settlement improvement performance have a weak cultural heritage, incomplete village infrastructure construction, and incomplete management of tourists on the part of village committees, all of which decrease the level of human settlement improvement performance in these traditional villages. For traditional villages with low human settlement improvement performance, their low performance is due to poor economic conditions, obstacles to transportation, inefficient work on the part of village committees, and a weak sense of participation on the part of villagers.

(2) In terms of the subdimensions of human settlement improvement performance in traditional villages, the value of the policy management dimension (0.88) is the highest, the values of the villagers dimension (0.48) and the learning and growth dimension (0.27) are in the middle, and the value of the financial benefits dimension (0.10) is the lowest. These findings reveal that the government and village committees are providing more effectively environmental governance and management while simultaneously highlighting the problems of financial constraints and unsatisfactory use of funds in traditional villages, which can

reduce human settlement improvement performance in traditional villages.

(3) The obstacles affecting the level of human settlement improvement performance in different types of traditional villages are characterized by both similarities and differences. Common obstacles in this context include the degree of handcrafted skill transmission (D13), the degree to which villagers participate in human settlement improvement (D2), and the number of popular human settlement improvement campaigns (D21). However, the degrees of influence exhibited by each obstacle factor differ. In addition to these common obstacles, the most notable obstacle to high levels of improvement performance is the number of knowledge training sessions conducted of human settlement (D20). The most notable obstacle regarding medium levels of improvement performance is the abundance of folklore activities (D12), and the most notable obstacle concerning low levels of improvement performance is the amount of funds earmarked for human settlement improvement (D7).

However, the above research has certain limitations. Firstly, there are deficiencies in the research methodology. Although the Balanced Scorecard theory used in this study is well-established and applied in various fields, its application in the evaluation of human settlement environment improvement performance is relatively rare and still needs further refinement and development. Secondly, there are limitations in data collection. Due to the large number and wide distribution of traditional villages, the sample villages selected are limited and do not cover all regions. Moreover, during data collection, it is inevitable that the differences in villagers' cognitive levels may influence the results. Finally, there are limitations in the research findings. The improvement of the living environment in traditional villages is an ongoing process, and as time progresses, the performance of the improvements may change. In conclusion, research on the performance level of human settlement environment improvement still requires a great deal of exploration and synthesis. It is expected that future studies will pay more attention to the performance of human settlement environment improvement in traditional villages, continuously enriching the research contents on the living environment of traditional villages.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

YH: Conceptualization, Funding acquisition, Visualization, Writing – original draft. CY: Data curation, Investigation, Methodology, Writing – original draft, Writing – review & editing. XM: Investigation, Writing – original draft. YG: Funding acquisition, Methodology, Software, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The authors declare that no Generative AI was used in the creation of this manuscript.

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References

Abedian, M., Shirouyehzad, H., and Davoodi, S. M. R. (2024). Improving performance evaluation based on the balanced scorecard with data envelopment analysis and game theory approaches: a case study. *J. Model. Manag.* 19, 1094–1113. doi: 10.1108/JM2-08-2023-0185

Angela, M., Jocelyn, M., Thulisa, M., Jackie, K., Brigitte, L., and Stuart, P. (2021). Housing quality in a rural and an urban settlement in South Africa. *Int. J. Environ. Res. Public Health* 18:2240. doi: 10.3390/ijerph18052240

Antonov, E. V., and Safronov, S. G. (2024). Evolution of rural settlement pattern in Kamchatka: from colonization to modern adaptation. *Reg. Res. Russ.* Suppl 1, S55–S64. doi: 10.1134/S2079970523600178

Beyene, E., Adam, A. G., and Minale, A. S. (2023). Examining the practice of urban governance using UN-habitat urban governance index in Gondar city, North West Ethiopia. *Cogent Soc. Sci.* 9:2208934. doi: 10.1080/23311886.2023.2208934

Celestino, S., and Silva, J. D. G. (2011). The balanced scorecard as a framework for strategic action. *Rev. Iberoam. Estratégia* 3, 147–172. doi: 10.5585/ijsm.v10i3.1747

Chaharlang, Y., Soleimani, H., Mehdizadeh, E., and Alinezhad, A. (2023). Introduction of an integrated system for measuring the BSC and DEA-based performance of social systems using uncontrollable factors: a case study of Shahriar municipalities. *Build* 13:242. doi: 10.3390/buildings13010242

Cheng, G., Dou, H., Xu, S., Dai, R., Liang, X., and Huang, Y. (2024). Rural human settlement environment improvement: process, status and China's sample. *Environ. Dev. Sustain.* 27, 1–28. doi: 10.1007/s10668-024-04686-3

Cho, S. J., Lee, J. S., and Hong, J. B. (2015). A case study on BSC (balanced score card) implementation in quasi-governmental organization; focused on the case of FIRA (Korea fisheries resources agency). *J. Fish. Bus. Admin.* 1, 121–143. doi: 10.12939/FBA.2015.46.1.121

Cui, Y., Wang, W., Yu, L., Zhou, W., and Fu, Z. (2022). Influence of livelihood capital level and structure on rural households' payment willingness for rural human settlement improvement: evidence from Hubei Province, China. *Agriculture* 12:1808. doi: 10.3390/agriculture12111808

Egidi, G., Halbac-Cotoara-Zamfir, R., Cividino, S., Quaranta, G., Salvati, L., and Colantoni, A. (2020). Rural in town: traditional agriculture, population trends, and Long-term urban expansion in metropolitan Rome. *Land* 9:53. doi: 10.3390/land9020053

Gao, C., Xia, S., Liu, J., Tao, H., and Zhu, Z. (2024). Adaptive evolution and dynamic mechanism of resort socioecological system in tourism cities: the case of Qinhuangdao, China. *Habitat Int.* 151:103138. doi: 10.1016/j.habitatint.2024.103138

Gong, X., Zhu, W. C., and Liu, S. (2020). The strategy of eco-agriculture economic development along the coast based on improving the rural eco-tourism environment. *J. Coast. Res.* 104, 652–655. doi: 10.2112/JCR-SI104-112.1

Harris, M., Alzua, M. L., Osbert, N., and Pickering, A. (2017). Community-level sanitation coverage more strongly associated with child growth and household drinking water quality than access to a private toilet in rural Mali. *Environ. Sci. Technol.* 51, 7219–7227. doi: 10.1021/acs.est.7b00178

Hu, Q., and Wang, C. (2020). Quality evaluation and division of regional types of rural human settlements in China. *Habitat Int.* 105:102278. doi: 10.1016/j.habitatint.2020.10227

Jing, F., Zhou, J. L., and Deng, Y. Y. (2021). Heritage values of ancient vernacular residences in traditional villages in Western Hunan, China: spatial patterns and influencing factors. *Build. Environ.* 188:107473. doi: 10.1016/J.BUILDENV.2020.107473

Karina, L. (2021). Rapidly changing cities: working with socio-ecological systems to facilitate transformation. *Urban Plan.* 2, 139–142. doi: 10.17645/up.v6i2.4472

Kleemann, J., Inkoom, J. N., Thiel, M., Shankar, S., Lautenbach, S., and Fürst, C. (2017). Peri-urban land use pattern and its relation to land use planning in Ghana, West Africa. *Landsc. Urban Plan.* 165, 280–294. doi: 10.1016/j.landurbplan.2017.02.004

Li, Y., Cao, L., Wang, P., and Chang, G. (2022). Rural living environment improvement and rural revitalization. *J. Nat. Res.* 37, 96–109. doi: 10.31497/zrzyxb.20220107

Li, B., Shi, Z., and Tian, C. (2018). Spatio-temporal difference and influencing factors of environmental adaptability measurement of human-sea economic system in Liaoning coastal area. *Chin. Geogr. Sci.* 28, 313–324. doi: 10.1007/s11769-018-0948-4

Li, B., Zheng, S., Dou, Y., Liu, P., and Zeng, C. (2019). Transformation and development mode of traditional village human settlement environment from the perspective of "double repairs": a case study of two typical villages in Hunan Province. *Prog. Geogr.* 9, 1412–1423. doi: 10.18306/dlkxjz.2019.09.014

Lin, Y., Yang, R., and Li, S. (2023). Rural development transformation and social governance from the perspective of specialization: a case study of Ruiling Village in Guangzhou City, China. *Chin. Geogr. Sci.* 5, 796–812. doi: 10.1007/s11769-023-1380-y

Liu, Q., Gong, D., and Gong, Y. (2022). Index system of rural human settlement in rural revitalization under the perspective of China. *Sci. Rep.* 12:10586. doi: 10.1038/s41598-022-13334-7

Liu, L., Hu, J., Hou, Y., Tao, Z., Chen, Z., and Chen, K. (2021). Pit latrines may be a potential risk in rural China and low-income countries when dealing with COVID-19. *Sci. Total Environ.* 761:143283. doi: 10.1016/j.scitotenv.2020.143283

Liu, J., Li, X., Liu, H., and Song, Y. (2023). The spatial and temporal evolution pattern and influencing factors of urban human settlement resilience in three provinces of Northeast China. *Land* 12:2161. doi: 10.3390/land12122161

Liu, Y., Schen, C., and Li, Y. (2015). Differentiation regularity of urban-rural equalized development at prefecture-level city in China. *J. Geogr. Sci.* 9, 1075–1088. doi: 10.1007/s11442-015-1220-9

Liu, Y., Ye, Q., Li, J., Kong, X., and Jiao, L. (2016). Suitability evaluation of rural settlements based on accessibility of production and living: a case study of Tingzu town in Hubei Province of China. *Chin. Geogr. Sci.* 26, 550–565. doi: 10.1007/s11769-015-0771-0

Liu, R., Zhang, L., Tang, Y., and Jiang, Y. (2024). Understanding and evaluating the resilience of rural human settlements with a social-ecological system framework: the case of Chongqing municipality, China. *Land Use Policy* 136:106966. doi: 10.1016/j.landusepol.2023.106966

Liu, J., Zheng, B., and Tang, H. (2023). The science of rural human settlements: a comprehensive overview. *Front. Environ. Sci.* 11:1274281. doi: 10.3389/fenvs.2023.1274281

Ma, H., Jing, C., Hu, A., and Ma, L. (2024). Evaluation of characteristics on the indoor dwelling environments of traditional villages in Hehuang area of China based on basic environmental parameters under remote sensing technology. *Phys. Chem. Earth Parts A/B/C* 134:103547. doi: 10.1016/j.pce.2024.103547

Ma, M., and Tang, J. (2023). Nonlinear impact and spatial effect of tourism urbanization on human settlement environment: evidence from the Yellow River Basin, China. *J. Clean. Prod.* 428:139432. doi: 10.1016/j.jclepro.2023.139432

Morse, A. L., and Robinson, G. M. (2024). The rural geography research group at 50: reflections on an evolving community of practice. *J. Rural. Stud.* 109:103344. doi: 10.1016/j.jrurstud.2024.103344

Mpofu, G., Darkoh, M. K., and Gwebu, T. (2018). Peri-urbanization landuse dynamics: an analysis of evolving patterns and their impacts on Gabane Village, Botswana. *GeoJournal* 83, 725–741. doi: 10.1007/s10708-017-9798-3

Mugisha, J., Uwayezu, E., Babere, N. J., and Kombe, W. J. (2024). Enabling planned urban settlements through land readjustment - a case study from Kigali, Rwanda. *Habitat Int.* 145:103025. doi: 10.1016/j.habitatint.2024.103025

Nikolaou, I. E., and Tsalis, T. A. (2013). Development of a sustainable balanced scorecard framework. *Ecol. Indic.* 34, 76–86. doi: 10.1016/j.ecolind.2013.04.005

Ntlhe, D. (2022). The transformation of compact rural human settlements in South Africa - the case of Elim in Limpopo. *Int. J. Sustainable Dev. Plan.* 17, 313–322. doi: 10.18280/ijsdp.170132

Qin, Y., Wang, L., Yu, M., Meng, X., Fan, Y., and Huang, Z. (2024). The spatio-temporal evolution and transformation mode of human settlement quality from the perspective of "production-living-ecological spaces--a case study of Jilin Province. *Habitat Int.* 145:103021. doi: 10.1016/j.habitatint.2024.103021

Ran, D., Hu, Q., and Zhang, Z. (2024). Spatial–temporal evolution, impact mechanisms, and reclamation potential of rural human settlements in China. *Land* 13:430. doi: 10.3390/land13040430

Rasoolimanesh, S. M., Jaafar, M., Badarulzaman, N., and Ramayah, T. (2015). Investigating a framework to facilitate the implementation of city development strategy using balanced scorecard. *Habitat Int.* 46, 156–165. doi: 10.1016/j.habitatint.2014.12.003

Rodríguez, J. M. P., Guida, A. G., and Márquez, Á. M. D. (2023). Urban metabolism of human settlements in small island-protected environments. *Environ. Sustain. Indic.*:100324. doi: 10.1016/j.indic.2023.100324

Stănilă, C., and Barbu, O. N. (2016). Socioeconomic valences of the human settlements in Tecuci plain in the context of sustainable development. *Ann. Valahia Univ. Targoviste Geogr. Ser.* 2, 75–86. doi: 10.1515/avutgs-2016-0007

Stephen, O., Arthur, W., and Rona, B. (2002). Community involvement in rural regeneration partnerships in the UK: key issues from a three nation study. *Reg. Stud.* 9, 1083–1092. doi: 10.1080/0034340022000024303

Strijker, D., Bosworth, G., and Bouter, G. (2020). Research methods in rural studies: qualitative, quantitative and mixed methods. *J. Rural. Stud.* 78, 262–270. doi: 10.1016/j.jrurstud.2020.06.007

Sun, Y., and Wang, N. (2022). Evolution and obstacle factors of high-quality industrial development in the π-shaped curve area of the Yellow River basin in China. *J. Geogr. Sci.* 32, 2430–2452. doi: 10.1007/s11442-022-2055-9

Tan, R., Hu, R., and Vatn, A. (2021). What does sustainability demand? An institutionalist analysis with applications to China. *J. Chinese Governance* 6, 486–514. doi: 10.1080/23812346.2021.1940690

Tang, L., and Long, H. (2022). Simulating the development of resilient human settlement in Changsha. *J. Geogr. Sci.* 32, 1513–1529. doi: 10.1007/s11442-022-2008-3

Tang, L., Ruth, M., He, Q., and Mirzaee, S. (2017). Comprehensive evaluation of trends in human settlements quality changes and spatial differentiation characteristics of 35 Chinese major cities. *Habitat Int.* 70, 81–90. doi: 10.1016/j.habitatint.2017.10.001

Tian, S., Li, X., Yang, J., Wang, H., and Guo, J. (2023). Spatiotemporal evolution of pseudo human settlements: case study of 36 cities in the three provinces of Northeast China from 2011 to 2018. *Environ. Dev. Sustain.* 25, 1742–1772. doi: 10.1007/s10668-022-02120-0

Wang, W., Gong, H., Yao, L., and Yu, L. (2021). Preference heterogeneity and payment willingness within rural households' participation in rural human settlement improvement. *J. Clean. Prod.* 312:127529. doi: 10.1016/j.jclepro.2021.127529

Wang, Y., Jin, C., Lu, M., and Lu, Y. (2017). Assessing the suitability of regional human settlements environment from a different preferences perspective: a case study of Zhejiang Province, China. *Habitat Int.* 70, 1–12. doi: 10.1016/j.habitatint.2017.09.010

Wang, P., Qin, X., and Li, Y. (2021). Satisfaction evaluation of rural human settlements in Northwest China: method and application. *Land* 10:813. doi: 10.3390/land10080813

Wang, Y., Song, Z., and Yang, Q. (2023). Resilience of Wengding, the Phoenix Wa traditional village. *Geogr. Sustain.* 4, 372–378. doi: 10.1016/j.geosus.2023.09.001

Wang, Y., and Zhu, Y. (2023). Exploring the effects of rural human settlement on rural development: evidence from Xianju County in Zhejiang Province, China. *Environ. Dev* 46:100845. doi: 10.1016/j.envdev.2023.100845

Wu, C., Chen, C., Du, P., Song, L., and Zhang, Y. (2023). Evaluation of rural human settlement environment in the middle and lower reaches of the Yellow River. *Pol. J. Environ. Stud.* 32, 321–330. doi: 10.15244/pjoes/153423

Yang, H., Tan, Y., Sun, X., Cheng, X., Liu, G., and Zhou, G. (2021). Comprehensive evaluation of water resources carrying capacity and analysis of obstacle factors in Weifang City based on hierarchical cluster analysis-VIKOR method. *Environ. Sci. Pollut. Res. Int.* 36, 50388–50404. doi: 10.1007/s11356-021-14236-3

Yang, J., You, H., Zhang, Y., and Jin, C. (2020). Research progress on human settlements: from traditional data to big data+. *Prog. Geogr.* 39, 166–176. doi: 10.18306/dlkxjz.2020.01.016

Ye, L., Wu, Z., Wang, T., Ding, K., and Chen, Y. (2022). Villagers' satisfaction evaluation system of rural human settlement construction: empirical study of Suzhou in China's rapid urbanization area. *Int. J. Environ. Res. Public Health* 19:11472. doi: 10.3390/ijerph191811472

Yin, J., Wang, D., Li, H., Li, Y., and Shang, Y. (2024). Spatial optimization of rural settlements in ecologically fragile regions based on a multi-agent model: evidence from different types of towns. *Environ. Impact Assess. Rev.* 106:107547. doi: 10.1016/j.eiar.2024.107547

Zhang, H., Liu, J., and Guo, Q. (2024). Evaluation of rural human settlements in China based on the combined model of DPSIR and PLS-SEM. *Environ. Impact Assess. Rev.* 108:107617. doi: 10.1016/j.eiar.2024.107617

Zhang, S., Xia, Y., Li, Z., Li, X., Wu, Y., and Liu, P. (2024). An assessment of urban residential environment quality based on multi-source geospatial data: a case study of Beijing, China. *Land* 13:823. doi: 10.3390/land13060823

Zhao, Y., and Long, B. (2020). Study on human settlement environment in Dai traditional villages of different regions. *IOP Conf. Ser. Earth Environ. Sci.* 568:012035. doi: 10.1088/1755-1315/568/1/012035

Zhao, Y. F., and Zhang, W. J. (2023). Exploring the path of village protection and renewal strategy based on the maximum information entropy model in the context of rural revitalisation. *Appl. Math. Nonlinear Sci.* 9:1. doi: 10.2478/AMNS-2024-1427

Zhou, J., Liu, L., Li, H., and Pei, D. (2021). Evaluation and analysis on suitability of human settlement environment in Qingdao. *PLoS One* 16:e0256502. doi: 10.1371/journal.pone.0256502

Zhu, W., Muhammad, A., Han, M., Li, Y., Kong, X., and Kong, F. (2022). Spatial distribution and aggregation of human-environment coordination and optimal paths in the Yellow River Delta, China. *Ecol. Indic.* 143:109380. doi: 10.1016/j.ecolind.2022.109380