

ORIGINAL RESEARCH ARTICLE

Research on evaluation of ecological livable city based on residents' satisfaction—Take Zhuzhou as an example

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ABSTRACT

Build an evaluation index system of ecological livable city, investigate the ecological livable level of Zhuzhou City from the perspective of residents' satisfaction, study the influencing factors of residents' satisfaction by using exploratory factor analysis, analysis of variance and correlation analysis, and calculate the ecological livable level of Zhuzhou City and its four main urban areas. The research results show that: (1) The satisfaction evaluation of ecological livability in Zhuzhou City is mainly composed of four-dimensional factors: urban participation, human settlements, urban security and human settlements economy, and the impact effect shows a decreasing trend. (2) There are significant differences in the satisfaction evaluation of various factors in terms of residents' age, educational background and length of residence, and there is a significant negative correlation between residents' sense of belonging and satisfaction. (3) The overall satisfaction level of ecological livability in Zhuzhou is general. Among the four main urban areas, lushong district has the highest satisfaction score and Hetang district has the lowest score. On this basis, put forward targeted policy suggestions to improve the ecological livability of Zhuzhou City.

Keywords: ecological livable city; residents' satisfaction; factor analysis; Zhuzhou

1. Introduction

The concepts of “ecological city” and “livable city” have been put forward by the “man and biosphere (mab)” plan in 1971 and the second United Nations Conference on human settlements in 1996 since the rise of the “pastoral city” movement due to the urban environmental crisis caused by the western industrial revolution at the end of the 19th century^[1,2]. Ecological livable city is the combination of the connotation of ecological city and livable city. With China's urbanization transformation and the increasing innovation of urban construction, the

evaluation standard of high-quality urban development has gradually changed from the mechanical improvement of urbanization rate to whether the city continues the old development mode of high environmental pollution and high resource consumption, and whether residents' life satisfaction and happiness have been improved. On December 20, 2015, the central urban work conference stressed the need to “build a harmonious, livable, dynamic and distinctive modern city” “Improving the livability of urban development” has been raised to a new height. On November 3, 2020, the Fifth Plenary Session of the 19th CPC Central

ARTICLE INFO

Received: June 13, 2022 | Accepted: July 24, 2022 | Available online: August 10, 2022

CITATION

Tan S. Research on evaluation of ecological livable city based on residents' satisfaction—Take Zhuzhou City as an example. *Eco Cities* 2022; 3(2): 12 pages.

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Committee deliberated and adopted the proposal of the CPC Central Committee on formulating the 14th Five Year Plan for national economic and social development and the long-term goals for 2035, which once again pointed out the need to “promote a new type of urbanization with people at the core” and “adhere to the realization, maintenance and development of the fundamental interests of the people as the starting point and foothold of development”^[3]. To further deepen urbanization, we should focus on people's needs, constantly improve residents' living environment, create comfortable living and recreational space, promote the harmonious development of the community, and make residents live a healthy and happy life.

At present, in foreign countries, developed countries have taken the lead in completing industrialization and entering the stage of rapid socio-economic development, exposing the contradiction between urban development and environmental sustainability earlier. Therefore, scholars in developed countries have also started their research on urban ecological environment quality and livability earlier, and their research in recent years has turned more to human well-being, resource security and so on^[4,5]. A large number of scholars from developing countries experiencing rapid urbanization began to think about the ecology and livability of their cities. For example, arpan used factor analysis and OLR model to study the ecological livability potential of Calcutta urban agglomeration in India^[6]. Elsalawy assessed the ecological livability of street communities by taking El atalin area in Alexandria, Egypt as an example^[7]. With the help of GIS software and standard deviation ellipse method, Ghasemi calculated the ecological livability of 22 districts in Tehran, Iran^[8]. Taking Argentine cities as an example, Oscar Nigro and others constructed an index system based on four dimensions including urbanity and diversity, nature and recreation, job opportunities and cost efficiency to calculate residents' satisfaction index^[9].

At home, scholars from all walks of life have also made fruitful research achievements on

ecologically livable cities. On the one hand, there are various research perspectives: including land use^[10,11], pollution control^[12], community construction^[13,14], etc. On the other hand, there are rich research methods, including factor analysis^[15], analytic hierarchy process (AHP)^[16,17], wind rose chart^[17], entropy weighting method^[18], matter-element analysis^[18,19], grey correlation degree method^[20], etc. Generally speaking, the research on eco livable cities at home and abroad has changed from paying attention to the urban living environment in the early stage to paying attention to the living and social environment at the same time. Whether residents can enjoy urban life equally and participate in urban construction has also become a new focus of benign urban development. However, most of the existing studies start from the perspective of the government and rely on the statistical yearbook data published by the government to evaluate the degree of ecological livable construction of the city^[15,17–19]. Although it can guarantee the authenticity, it lacks more flexible evaluation indicators and can not reflect the subjective feelings of residents, and the evaluation results may be higher than the actual situation.

Based on this, this paper aims to establish an urban ecological livable evaluation and construction research system from the perspective of residents, focusing on the subjective feelings of residents about urban residence. Through empirical research such as questionnaire survey and data recovery analysis, this paper analyzes the main factors affecting residents' evaluation of urban satisfaction, analyzes the relationship between various influencing factors, and explores the necessary conditions and relevant measures for building an ecologically livable city, so as to provide feasible suggestions for further improving the urban living environment.

Zhuzhou, as an old industrial city that was the focus of the state in the early days of the founding of new China, once suffered great damage to its ecological environment. However, in recent years, Zhuzhou has actively responded to the call of the state, constructed the urban development pattern

according to the development orientation of an ecological and livable city characterized by modern industrial civilization, and achieved outstanding results. Therefore, taking Zhuzhou as the research object, evaluating the current situation of urban ecological livable construction and exploring the development path of urban ecological livable have certain reference significance for the development and construction of similar old industrial cities focusing on industrial structure adjustment and upgrading and urban renewal and transformation.

2. Research design

2.1. Overview of the study area

Zhuzhou is a city developed with China's modernization drive. As an old industrial city, in the process of urbanization after the reform and opening up, the contradiction between urban economic development and resources and environment was once more prominent. However, in recent years, heavy polluting enterprises have been shut down and relocated one after another, and the industrial structure has been upgraded. The government has deeply implemented actions such as smooth traffic, urban shade, improving the quality of old cities, clear water and blue sky, and supporting public facilities. Zhuzhou has gradually developed into a city integrating mountains, water, bridges and cities, with beautiful environment and livable ecology, it has successfully created "national civilized city", "national water ecological civilized city", "national garden city" and "China's top ten cities with the most investment value", won the "China living environment example award", known as "the cleanest city in Hunan Province", and was selected as one of the "40 cities with the most successful economic development in the 40 years of reform and opening up"^[21].

2.2. Questionnaire design

Follow the principles of systematic comprehensiveness, scientific orientation, operability and

people-oriented, refer to the evaluation indicators of urban ecological livability of domestic and foreign scholars, refer to the composition of the perception dimension of urban residents' satisfaction^[22–26], and design the questionnaire in combination with the characteristics of Zhuzhou City. The content is divided into two parts around residents' demands for ecological livability of the city. One part is demographic variables, such as gender, age, occupation, education level, family composition, monthly income, etc. The other part is the index content of measuring ecologically livable cities, covering six dimensions of human settlements economy, social security, infrastructure, ecological environment, urban culture and government policies, and 24 sub indicators (**Figure 1**). According to the 5-level Likert scale method, the sub indicators are transformed into corresponding questions, such as "are you satisfied with the housing price level in Zhuzhou?" The answer has five options, from low to high, which are very dissatisfied, dissatisfied, average, satisfied and very satisfied.

In addition, two questions of urban belonging and pride are added in order to more accurately grasp the urban ecological livable level in the hearts of residents from the emotional aspect.

2.3. Data source and processing

Taking the residents of Zhuzhou City as the research object, a combination of questionnaire survey and interview was adopted. From September 9 to 13, 020,320 questionnaires were randomly distributed in the crowded areas of Zhuzhou City, such as central square, scenic belt along the river, Shennong Park and Shennong Lake Park, and 301 valid questionnaires were recovered, with an effective rate of 94.06%. The detailed composition of the sample (**Table 1**) shows that the respondents include residents with different socio-economic attributes. The sample distribution is relatively average and has good representativeness on the whole.

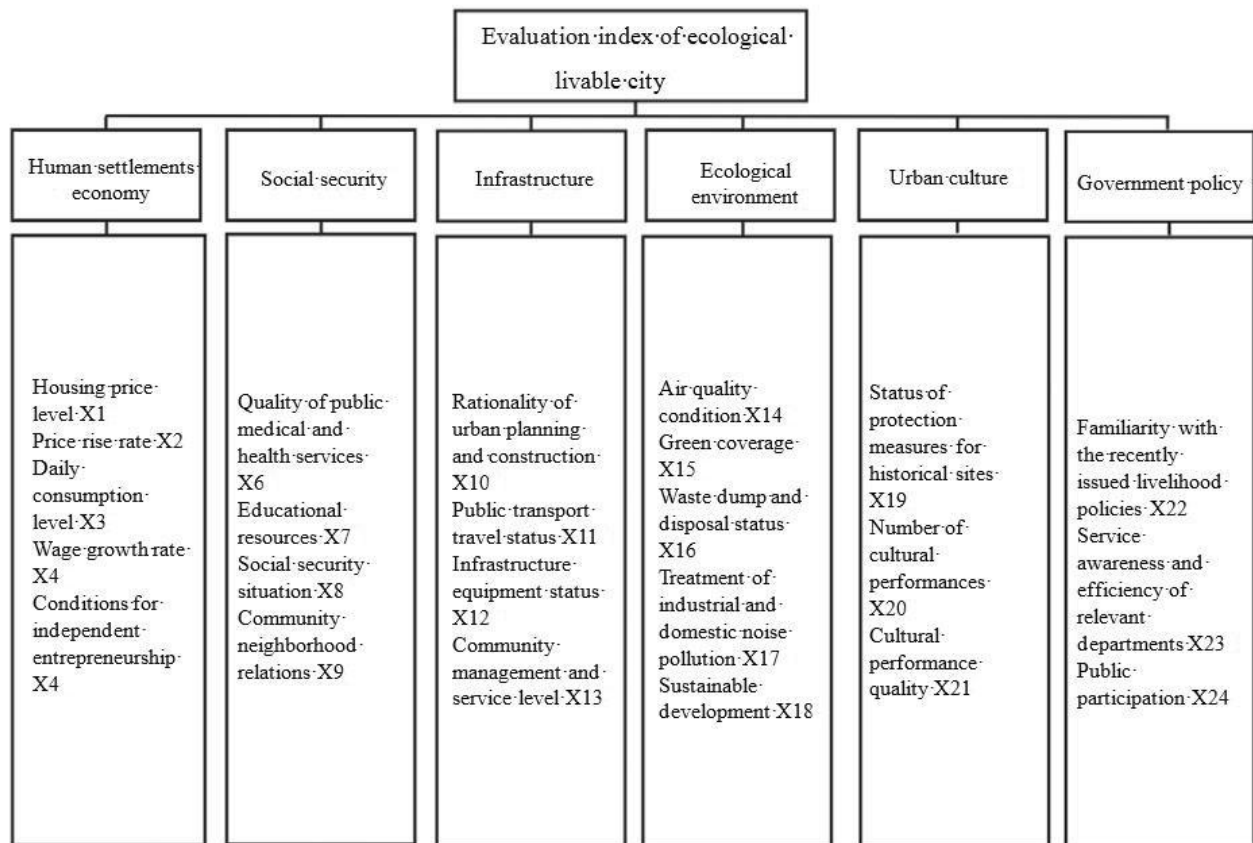


Figure 1. Evaluation index of eco livable city.

Table 1. Composition of survey samples

Basic information	Option	Number of samples	Proportion/%	Basic information	Option	Number of samples	Proportion/%
Gender	Male	144	47.8	Monthly income (yuan)	Below 3,000	65	21.6
	Female	157	52.2		3,001–5,000	111	36.9
Age	25 and below	36	11.9		5,001–8,000	79	26.2
	26–30	18	6.0		8,001–10,000	25	8.3
	31–40	64	21.3		Over 10,000	21	7.0
	41–50	71	23.6	Family composition	Single	40	13.3
	51–60	61	20.3		Two families	35	11.6
	Above 60	51	16.9		Three families	122	40.5
Education	Junior high school	44	14.6		Four families	50	16.6
	High school	34	11.3		More than five families	54	17.9
Occupation	Specialty	60	19.9	Place of residence	Hetang District	35	11.6
	Undergraduate	122	40.6		Lushong District	76	25.2
	Master degree or above	41	13.6		Shifeng District	39	13.0
	Student	23	7.6		Tianyuan District	142	47.2
	Government Civil Servants	23	7.6		Other area	5	1.7
	Enterprises and institutions	85	28.2	Length of stay in Zhuzhou	Other	4	1.3
	Individual	27	9.0		Within 1 year	5	1.7
	Liberal professions	44	14.6		3–1 years	19	6.3
	Retirement	73	24.3		3–6 years	19	6.3
	Other	26	8.6		6–10 years	32	10.6
					More than 10 years	226	75.1

Table 2. Factor extraction results after factor analysis

Factor	Initial eigenvalue			Extract the sum of squares of loads			Sum of squares of rotating loads		
	Total	Variance/%	Cumulative/%	Total	Variance/%	Cumulative/%	Total	Variance/%	Cumulative/%
F_1	10.638	44.323	44.323	10.638	44.323	44.323	4.458	18.574	18.574
F_2	1.572	6.548	50.871	1.572	6.548	50.871	3.735	15.562	34.136
F_3	1.334	5.560	56.431	1.334	5.560	56.431	3.329	13.870	48.006
F_4	1.160	4.833	61.264	1.160	4.833	61.264	3.182	13.257	61.264

3. Empirical analysis

3.1. Exploratory factor analysis of residents' satisfaction

Sort out the collected questionnaire data, use factor analysis method to make mathematical analysis on various eco livable indicators, and reveal the subjective evaluation of Zhuzhou residents on Urban Eco livable satisfaction, so as to reflect the overall level of urban eco livable construction.

Factor analysis is to use the dimension reduction method to synthesize the variables complex relationships into a few factors, so as to reproduce the relationship between the original variables and factors, and explore how many measured indicators that can be measured directly and have certain correlation are dominated by a few internal independent factors.

Before factor analysis, kmo and Bartlett spherical tests were conducted on 24 variables affecting residents' satisfaction. According to the standard given by the statistician Kaiser, when $kmo > 0.9$, the effect of factor analysis is the best^[27]. The kmo test value obtained in this study is 0.938, and there is no significant difference in the degree of correlation between variables. The approximate chi square value of Bartlett spherical test is 4,037.827, the degree of freedom value is 276, and the significance value is 0.000, which is less than 0.05. Therefore, the null hypothesis of Bartlett spherical test is rejected. The values of various variable indexes are related, and the samples are suitable for factor analysis.

Analysis of variance was performed to obtain the results of factor extraction (Table 2). The results show that the characteristic roots of the first four factors are > 1 , and the cumulative variance

contribution rate is 61.264% after factor rotation by the maximum variance method. The characteristic root of the fifth factor is $0.874 < 1$, indicating that the interpretation of this factor is not as strong as that of directly introducing the original variable, so only the first four factors need to be extracted. According to the variance contribution rate, set these four factors as F_1 , F_2 , F_3 and F_4 respectively.

The results show that the variance contribution rate of the main factor F_1 is 18.574%. The factor load coefficient is high in "public participation, policy familiarity, the number and quality of cultural performances, historical site protection, service awareness of relevant departments, independent entrepreneurial environment and sustainable development". These matters involve the interaction between citizens and urban publicity departments and cultural departments, reflecting the participation level of citizens in urban policies and cultural activities, named "city participation". The variance contribution rate of the main factor F_2 is 15.562%, which has a large load in "residential greening, infrastructure, waste disposal, air quality, industrial pollution and management services". These matters mainly involve the environmental conditions in and around the residential area, which is named "residential environment". The variance contribution rate of the main factor F_3 is 13.870%, which has a large load in "social security, neighborhood relations, educational resources, medical resources, transportation and urban planning". These matters involve various facilities and service guarantees for residents, which are named "urban security". The variance contribution rate of the main factor F_4 is 13.257%, which has a large load on "housing price, price rise rate, daily consumption level and wage growth rate". These matters involve urban economic and living conditions and are named "human settlements economy".

3.2. Difference analysis of residents'

economic and social attributes' satisfaction with various factors

Firstly, the socio-economic attribute characteristics of the surveyed residents are quantified in a certain logical order (Table 3), and then the difference between the quantitative value of each attribute and the mean value of the variables included in the four eco livable satisfaction factors and the degree of residents' sense of belonging (Table 4) is analyzed. The results show that there are significant differences in the satisfaction of each factor by age, educational background and length of residence. The correlation test between the sense of belonging and the satisfaction of each factor (Table 5) shows that there is a significant negative correlation between them.

(1) Age attribute. There are significant differences in the satisfaction of residents of different ages with urban living economy, urban security, living environment and urban participation (Table 6), and the average curve of overall satisfaction presents a “W” shape (Figure 2). The average satisfaction of residents under 25 and over 60 with each factor is significantly higher than that of other age groups. Residents aged 26–30 and 51–60 have the lowest satisfaction with each factor. Residents aged 31–40 have the strongest sense of belonging.

(2) Educational attributes. Residents with different levels of education have significant differences in their satisfaction with urban security, living environment and sense of belonging (Table 7), and the average curve of overall satisfaction presents a “V” shape (Figure 2). The average satisfaction of residents with junior middle school or below on urban security and human settlements economy is significantly higher than that of residents with senior high school or college education. Residents with high school and college degrees have the lowest

satisfaction with each factor, which is basically consistent with the difference of satisfaction of age groups. Highly educated residents have the strongest sense of belonging.

(3) Residence duration attribute. There are significant differences in residents' satisfaction with urban human settlements economy, human settlements environment and social participation for different length of residence (Table 8). The average curve of overall satisfaction shows a long tail “anti-N” type (Figure 2). The average satisfaction of residents who have lived in Zhuzhou for more than 10 years is significantly lower than that of residents who have lived for a short time. Residents who have lived for 3–6 years have the highest satisfaction with human settlements economy, human settlements environment and urban participation. Residents who have lived for less than one year and 6–10 years have the strongest sense of belonging.

The above analysis shows that there are obvious differences in the satisfaction of different residents' socio-economic attributes with various indicators of the city and their sense of belonging to the city, indicating that residents' socio-economic attributes are one of the important factors affecting the satisfaction evaluation of urban ecological livability.

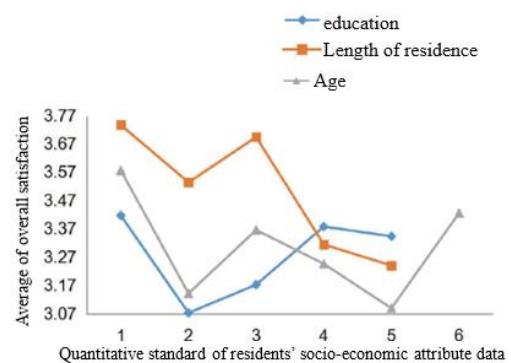


Figure 2. Average curve of overall satisfaction with age, educational background and length of residence.

Table 3. Quantitative standard of residents' socio-economic attribute data

Attribute	Assignment
Age/year	1 = 25 and below; 2 = 26–30; 3 = 31–40; 4 = 41–50; 5 = 51–60; 6 = above 60
Education	1 = junior high school and below; 2 = high school; 3 = specialist; 4 = Bachelor degree; 5 = Master degree or above
Family composition	1 = single; 2 = family of two; 3 = family of three; 4 = family of four; 5 = family of five or more
Monthly income/yuan	1 = less than 3,000; 2 = 3 001–5,000; 3 = 5,001–8,000; 4 = 8,001–10,000; 5 = more than 10,000
Length of residence	1 = within 1 year; 2 = 1–3 years; 3 = 3–6 years; 4 = 6–10 years; 5 = more than 10 years

Table 4. Difference analysis of residents' social and economic attributes' satisfaction with various factors

Social and economic attributes of residents	Human settlements economy	Urban security	Living environment	Urban participation
Age	0.000***	0.012**	0.007***	0.003
Education	0.057	0.025**	0.015**	0.056
Family composition	0.608	0.491	0.548	0.679
Monthly income	0.416	0.771	0.590	0.224
Length of residence	0.001***	0.096	0.002***	0.003

Note: ** indicates significant at 95% level*** It means significant at 99% level.

Table 5. Correlation test between sense of belonging and satisfaction of various factors

Project	Correlation analysis	Human settlements economy	Urban security	Living environment	Urban participation
Sense of belonging	Pearson correlation	-0.346***	-0.499***	-0.431***	-0.505***
	Sig. (double tailed)	0.000	0.000	0.000	0.000

Note: *** means significant at 99%.

Table 6. One-way ANOVA and post test of satisfaction of different ages with each factor

	Human settlements economy	Urban security	Living environment	Urban participation	Sense of belonging
Age	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$
25 and under	3.417 \pm 0.751	3.750 \pm 0.628	3.653 \pm 0.647	3.490 \pm 0.664	2.097 \pm 0.773
26–30	2.708 \pm 0.796	3.426 \pm 0.741	3306 \pm 0.915	3.132 \pm 0.683	2.278 \pm 1.060
31–40	3.004 \pm 0.541	3.576 \pm 0.572	3.568 \pm 0.680	3.320 \pm 0.604	2.438 \pm 0.726
41–50	2.813 \pm 0.718	3.502 \pm 0.523	3.345 \pm 0.643	3.329 \pm 0.519	2.303 \pm 0.646
51–60	2.766 \pm 0.802	3.363 \pm 0.633	3.191 \pm 0.755	3.041 \pm 0.598	2.336 \pm 0.778
Above 60	3.132 \pm 0.584	3.676 \pm 0.417	3.523 \pm 0.592	3.490 \pm 0.664	2.069 \pm 0.592
F	5.909	2.993	3.277	3.758	1.992
Sig.	0.000***	0.012**	0.007***	0.003***	0.080
LSD	1>2, 3, 4	51>2, 4, 5	1>2, 4, 5	1>2, 5	

Note: * * indicates significant at 95% level*** It means significant at 99% level

Table 7. One-way ANOVA and post test of satisfaction of different educational background to each factor

Education	Human settlements economy	Urban security	Living environment	Urban participation	Sense of belonging
	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$
Junior high school and below	3.102 \pm 0.862	3.648 \pm 0.524	3.576 \pm 0.763	3.347 \pm 0.534	2.193 \pm 0.787
High school	2.757 \pm 0.767	3.304 \pm 0.697	3.191 \pm 0.802	3.044 \pm 0.676	2.191 \pm 0.826
Specialty	2.800 \pm 0.624	3.442 \pm 0.549	3239 \pm 0.602	3.215 \pm 0.540	2.433 \pm 0.686
Undergraduate	3.043 \pm 0.707	3.615 \pm 0.547	3.496 \pm 0.687	3.362 \pm 0.583	2.164 \pm 0.697
Master degree or above	2.994 \pm 0.619	3.573 \pm 0.612	3.524 \pm 0.625	3.287 \pm 0.602	2.512 \pm 0.711
F	2.320	2.835	3.138	2.329	2.777
Sig.	0.057	0.025**	0.015**	0.056	0.027**
LSD		2 <1, 4, 5	1 >2, 3		5 >1, 2, 4

Table 8. One-way ANOVA and post test of satisfaction with various factors for different length of residence

Length of residence	Human settlements economy	Urban security	Living environment	Urban participation	Sense of belonging
	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$	$\bar{X} \pm SD$
Within 1 year	3.450 \pm 0.542	4.000 \pm 0.656	3.900 \pm 0.769	3.600 \pm 0.311	2.600 \pm 0.224
1–3 years	3.368 \pm 0.742	3.544 \pm 0.496	3.623 \pm 0.590	3.605 \pm 0.548	2.342 \pm 0.883
3–6 years	3.421 \pm 0.717	3.807 \pm 0.504	3.921 \pm 0.573	3.632 \pm 0.454	2.184 \pm 0.606
6–10 years	2.984 \pm 0.783	3.563 \pm 0.561	3.490 \pm 0.763	3.227 \pm 0.618	2.500 \pm 0.660
More than 10 years	2.878 \pm 0.685	3.510 \pm 0.586	3.348 \pm 0.686	3.229 \pm 0.583	2.235 \pm 0.744
F value	5.072	1.991	4.287	4.193	1.285
Sig.	0.001***	0.096	0.002***	0.003***	0.276
LSD	5 <1,2, 3		5 <3	5 <2,3	

Note: *** means significant at 99%.

3.3. Urban ecological livable satisfaction score

In order to calculate the overall satisfaction of Zhuzhou residents with urban ecological livability, the scores of 1–5 on the 5-level Likert scale are

assigned 40, 55, 70, 85 and 100^[24], and the proportion of the variance contribution rate of each factor in the variance contribution rate of the total factor is used as the weight to weight the objective score of each factor, and a linear weighted comprehensive evaluation model is established:

$$Y=0.303F_1+0.254F_2+0.226F_3+0.216F_4 \quad (1)$$

Thus, the comprehensive score of ecological livability satisfaction of Zhuzhou City is calculated (Table 9). Using the same method, calculate the ecological livability satisfaction score of four main urban areas of Zhuzhou: Hetang District, lushong District, Shifeng District and Tianyuan District (because the sample size of Lukou district and other areas is too small, it is not included in the analysis) (Table 10).

According to the comprehensive evaluation calculation and classification of the above index

Table 9. Evaluation index scores of ecologically livable cities

First level indicators	Secondary indicators	Average score	Factor weight	Score
Evaluation index of ecological livable city	Urban participation	74.26	0.303	22.50
	Living environment	76.39	0.254	19.40
	Urban security	78.16	0.226	17.67
	Human settlements economy	69.46	0.216	15.00
	Total score			74.57

Table 10. Evaluation scores of ecological livability in 4 main urban areas

Project	Hetang District	Lushong District	Shifeng District	Tianyuan District
Urban participation factor score	22.38	21.66	22.26	22.32
Human settlements factor score	18.96	20.16	19.55	19.16
Urban security factor score	17.53	17.66	17.17	17.62
Residential economic factor score	14.06	16.27	14.75	15.02
Total score	72.92	75.75	73.73	74.12

Lushong District ranks first in the score of ecological livability, with a total score of 75.75, indicating that the overall construction of the district is reasonable and the satisfaction of residents is high. Tianyuan District scored 74.12, ranking second; Shifeng District scored 73.73, ranking third; Hetang District scored 72.92, ranking fourth. It shows that the residents in these three districts are generally satisfied. The reason is that lushong district is the earliest central urban area of Zhuzhou, with rapid economic development. It has many business districts such as Dahan Hilton joy center, Wangfujing and Pinghetang, which greatly enriches residents' consumption. In addition, the scenic belt and leisure park along the Xiangjiang River, which are continuously reconstructed and upgraded, fully meet the recreational needs of residents. Residents are highly satisfied with house prices, prices and income.

system and referring to the classification of relevant comprehensive indexes at home and abroad, appropriately adjust and divide a five-level city livable degree standard. A score ≥ 90 indicates that the satisfaction of ecological livable is very high, a score ≥ 75 indicates that the satisfaction of ecological livable is high, a score ≥ 60 indicates that the satisfaction of ecological livable is general, and a score $\geq 60 > \text{score} \geq 45$ indicates that the satisfaction of ecological livable is low, score < 45 indicates low livability satisfaction^[28]. The total score of satisfaction evaluation of ecological livability in Zhuzhou City obtained from the above research is 74.57, and the overall satisfaction of residents is average and relatively high.

However, the satisfaction of the people in lushong District in terms of cultural atmosphere and government participation is lower than that in the other three districts, indicating that there are still some unsatisfactory areas that need to be improved. Hetang district has the lowest score, and its living environment is hard injury. During the visit, many residents in Hetang District complained that the quality of living environment is low due to the early construction of the community, the aging facilities and the lack of effective management.

4. Conclusions and suggestions

4.1. Research conclusion

Based on the questionnaire survey data of residents' satisfaction with ecological livability in Zhuzhou, this study studies the factors and influence

degree affecting residents' satisfaction through exploratory factor analysis, analysis of variance and correlation analysis, calculates the score of ecological livability satisfaction in Zhuzhou and the main urban areas, discusses the residents' satisfaction with urban ecological livability under the background of new urbanization with people as the core, and draws the following conclusions.

Firstly, the construction of urban connotation and quality has become the most important symbol of urban development. The research results show that the most important indicators to evaluate whether the city is ecologically livable have given way to urban culture, government services and public participation from urban economic indicators and infrastructure construction level, which reflects that the demand of citizens has changed from low demand on social material level to high demand on cultural and spiritual level. To improve residents' satisfaction with urban ecological livability, we need not only to improve the infrastructure and ecological environment construction, but also to improve the construction of urban spiritual civilization through various channels and methods, strengthen residents' sense of urban belonging, and realize residents' Self-worth in the city, so as to obtain higher-level satisfaction.

Secondly, there are significant differences in satisfaction evaluation between residents' socio-economic attributes. The research results show that there are significant differences in the satisfaction of residents of different ages, educational backgrounds and living hours on the factors of urban ecological livability. The mean curve of satisfaction is "W", "V" and long tail "anti-N" respectively, and the satisfaction is negatively correlated with the sense of belonging. Residents aged 25 and below and 60 and above have significantly higher satisfaction with various factors than residents of other ages, but their sense of belonging and pride are not strong. Residents with high school and college degrees and citizens who have lived in the city for more than 10 years have low satisfaction with various factors, indicating that these citizens have higher

expectations for the development of their hometown, while the construction level of the city in all aspects has not fully met the people's yearning for a better and growing life. The shortage of residents' activity space and the pressure on economic life deserve attention. People aged 31–40 with master's degree or above who have lived in Zhuzhou for 6–10 years have a high sense of belonging to the city.

Thirdly, the overall livable satisfaction level of Zhuzhou City is average. Among them, the economic satisfaction of human settlements is the lowest. The rate of dissatisfaction with the rate of price rise and wage growth reached 32.9% and 35.9% respectively, reflecting that residents feel that the rate of price rise is relatively fast in recent years, while the rate of wage income rise is relatively small, and the satisfaction with daily consumption level and house price level is average. The satisfaction with urban participation is low. The dissatisfaction rates with the familiarity with the relevant livelihood policies issued by the government and the service awareness and efficiency of relevant departments are 15.6% and 13.3% respectively, reflecting that although residents have strong willingness to participate, their actual participation is not high, there are few participation channels, and there are also problems such as weak service awareness of relevant departments in the process of participation. In terms of living environment, the satisfaction with the disposal of garbage dumps in the community and the noise pollution of industrial life is low, especially in some old communities, the health status needs to be improved, and the noise pollution problem can not be underestimated. The satisfaction of urban security is relatively the highest. Except that the dissatisfaction rates of public medical and educational resources are 18.3% and 13.3% respectively, the dissatisfaction rates of other indicators are lower than 10.0%, indicating that there are relatively few urban medical and educational resources. Cities should increase investment in medical and education to meet the needs of residents for medical and educational security. The ecological livability scores of four main urban areas are calculated respectively, among which Lusong

District ranks first, Tianyuan District ranks second, Shifeng District ranks third and Hetang District ranks fourth. The score gap is mainly reflected in the factors of human settlements economy and human settlements environment. The overall income level of residents in the lower ranking areas is low, and there are problems in infrastructure construction, ecological environment construction and so on.

4.2. Policy recommendations

The evaluation of urban ecological livable satisfaction is a complex task. The measurement indicators include many factors. These factors interact and are indispensable, which jointly affect the quality and connotation of urban construction. To improve the ecological livability of cities, we should take the promotion and support of the government as the leading role, go deep into various subdivided factors, develop strengths and avoid weaknesses, and put forward the following suggestions.

Firstly, raise income, control prices and house prices, and enhance residents' happiness. Zhuzhou had a certain industrial foundation and economic development level earlier, but the low wage income level and the rising house prices in recent years have caused obvious dissatisfaction among residents. Therefore, on the one hand, the government should keep pace with the times, constantly adjust and optimize the industrial structure, constantly improve the income level of high-tech talents, and optimize the entrepreneurial environment, so as to make Zhuzhou truly a livable and happy place for talents; on the other hand, the government should activate and standardize the existing labor and employment market, provide more employment and development opportunities for ordinary residents, and increase residents' income through multiple channels and aspects. In addition, Zhuzhou should also introduce corresponding measures to prevent house prices from rising too fast and too much. At the same time, increase the construction and supply proportion of low rent housing, affordable housing and affordable housing, and implement housing, in kind or monetary subsidies for residents with special

difficulties, so as to effectively improve the happiness of Zhuzhou ecological and livable city.

Secondly, strengthen infrastructure construction, improve the social security system and improve the function of ecological and livable cities. Infrastructure factors and social security factors are both "hard" and "soft", which is an important support for building an ecologically livable city. Zhuzhou should continue to vigorously promote the construction of urban infrastructure, such as accelerating the construction of intelligent track and promoting the construction of Changsha Zhuzhou Xiangtan Urban Track. Actively explore new forms of community construction, create a good community neighborhood atmosphere, maintain social security and stability, ensure that community residents have full and equal access to public health care, education and other resources, constantly improve the social security system, steadily improve the level of social security, and further improve the function of an ecologically livable city.

Thirdly, strengthen urban brand building, encourage public participation and improve residents' sense of belonging to the city. City brand is the core competitiveness of a city, and a city with characteristics can attract and retain talents. Zhuzhou should advocate to carry out a variety of public welfare activities and cultural activities with local cultural characteristics at regional, community and other levels, so as to create an urban community atmosphere of unity and mutual assistance, civilization and harmony and distinctive cultural characteristics for citizens, and enhance residents' sense of pride and belonging. At the same time, broaden the channels of public participation, build a multi-level communication platform, advocate public participation in major decision-making activities of urban and community construction, widely solicit the opinions of all sectors of society, and timely answer the hot issues concerned by the masses, so as to make urban planning, construction and management more democratic and transparent. Especially in matters related to people's livelihood, it is necessary to ensure the

people's right to know, which can not only improve citizens' satisfaction with decision-making work, but also shorten the distance between government departments and the people, and to safeguard and protect the vital interests of the people to the greatest extent possible.

In the research process, it is found that there is a significant negative correlation between urban satisfaction and sense of belonging. However, due to the lack of deep deconstruction of the dimension of sense of belonging, this phenomenon cannot be accurately explained. In the future, an evaluation index model of sense of belonging can be established in order to conduct more in-depth research and analysis on this problem.

Conflict of interest

The author declares no conflict of interest.

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