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Analysis on the Weights of Green Space Index of Cold Rural Houses Based on Expert Decision

Sun Chutian[1], Qu Guangbin[1], Hu Yujie[1]

[1]School of Architecture, Harbin Institute of Technology; Key Laboratory of Cold Regi on Urban and Rural Human Settlement Environment Science and Technology, Ministr y of Industry and Information Technology, West Dazhi Street 66,Harbin,China.

Corresponding author's Tel:15846006793 E-mail address:466190935@qq.com

Abstract: The residential courtyard in the rural areas of the cold area is inseparable from the life of the elderly. The quality of the courtyard green space closely affects the health status of the elderly.This paper selects the green space of the rural residential courtyard in the cold area as the research object. Firstly, it uses the literature analysis and the rooted theory to construct the evaluation index model. Secondly, the fuzzy Delphi method is used to modify the evaluation index system. Finally, the analytic hierarchy process is used to assign local and global weights to the indicators from the perspective of expert groups. In cold areas,the importance of the indicators, of the green space of rural houses,are explored for the health of the elderly.It provides reference and reference for the design decision-making stage of the health promotion optimization of the residential courtyard green space.

1. Introduction

As the most severely aging population in China, rural areas in China are one of the more significant problems due to the aging of human body structure and physiological functions and the influence of unhealthy lifestyles and space environment factors[1]. According to the survey, more than 75% of rural elderly are very concerned about their health status. At present, the relevant research relationship between rural and elderly health is mainly focused on the research of health mechanism and review from the perspective of sociology[2],health support research from the perspective of agricultural economy[3],focusing on health census with public health and clinical medicine as the entry point[4]. Study on the health status of the elderly population with demographics as the background[5]. Humanities and social sciences such as economics, sociology and demography have already conducted a more indepth discussion on the health-related issues of the elderly. The article focuses on the interaction space between physical space environment and health, focusing on the green space of rural residential courtyards in the cold, through the establishment and correction of weight assignment objects, and finally discussing the local and global weights of evaluation indicators. Exploring the importance of environmental factors in the green space of rural houses to the health of the elderly in order to lay a certain theoretical foundation and practical guiding significance for the healthy construction of rural houses in cold regions.

2. Selection and application of research methods

Firstly, the article firstly constructs the evaluation index system model through literature analysis and grounded theory. Secondly, the fuzzy Delphi method is used to modify the index model. Finally, the

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analytic hierarchy process is used to assign weights.Exploring the important role of the evaluation index in the rural elderly. The process is shown in Figure 1.

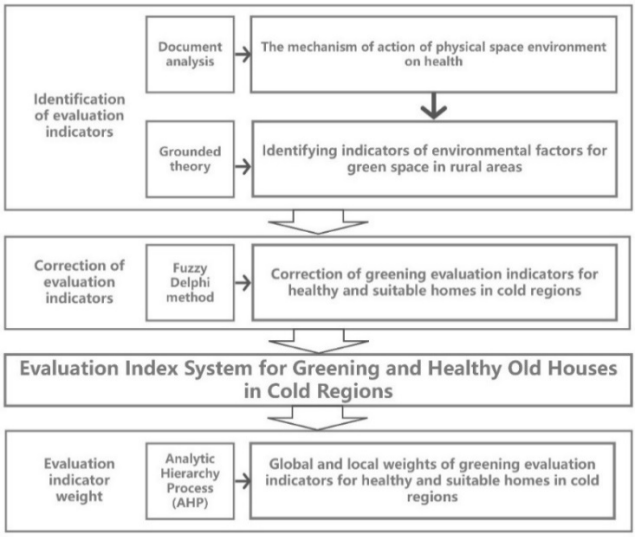


Figure 1. Process for evaluating index weight assignment

The literature analysis can initially construct the framework of the evaluation indicators for preliminary construction. According to the ICF evaluation framework in the World Health Organization white paper report, the index framework is constructed, and the "Healthy Rural Elderly in the Cold Region" is established as the target layer, and Through the ICF, outdoor activities, close to nature and social interaction[6], the mechanism of action of three outdoor spaces and physical spaces to determine the criteria layer based on the target layer.

Grounded theory is a qualitative research method that is rooted in empirical data and constructs theory through normative and rigorous research procedures. The grounded theory overcomes the lack of normative methodological support in general qualitative research, the difficulty in tracing and testing the research process, and the conclusion that the conclusions are not convincing. The method is considered to be the most scientific methodology in qualitative research and the most suitable for theoretical construction method [7]. Through the grounding theory, the initial sampling, theoretical sampling, based on the core category, using the open, selective, theoretical coding of the three criteria layers, the summary and comparative analysis of a large number of documents reached the data saturation stage, thus the evaluation indicators under the criterion layer are identified.

The fuzzy Delphi method can effectively quantify the judgment results of the expert groups on the correlation of each index to this study[8]. The fuzzy Delphi method relies on expert group decision making and uses discrete fuzzy numbers to perform operations, which is beneficial to the definition of thresholds in the selection process of indicators[9].As shown in table 1, the expert group will judge the importance of each indicator.

Table 1.Experts semantic Scale

Semantic scale	Very important	Important	Common	Unimportant	Very unimportant
Semantic metric	5	4	3	2	1
Decision result	Reserved	Reserved	Discussion	Delete	Delete

The Analytic Hierarchy Process (AHP) is used to assign the weight of the evaluation index to the evaluation index of the expert group. Through the evaluation of the local weight of the evaluation level and the global weight of the evaluation index, the degree of influence of the evaluation index on the health promotion of the elderly is obtained. Quantify the assessment results to measure the extent to which the evaluation indicators affect the impact of the evaluation objectives.

3. Identification of evaluation indicators

The identification of evaluation indicators is divided into two stages, the mechanism of action in the International Health and Mental Disorders Classification System (ICF): outdoor activities, close to nature, social interaction establishment criteria: promoting outdoor activities, closing to nature, social interaction.The rural environment is suitable for the environment of the elderly. Secondly, based on the criterion layer, a large number of documents are identified based on the rooted theory.

3.1 Preliminary identification of evaluation indicators based on grounded theory Based on the formed evaluation criteria layer, it is the core category for open coding, axis coding, and selective coding of the substantial coding process until the selective coding reaches the theoretical saturation stage.The semantics are summarized and integrated in a large number of documents, and the evaluation indicators under the evaluation criteria layer are initially identified.

Under the guidelines of the “Elements of Space Environment for Outdoor Activities”,Preliminary selecting, 5 main categories under the core issues of “Auxiliary Courtyard Activities”, “Diversified Garden Green Space Types”, “High Quality Walking Pavement”, “Sufficient Courtyard Lighting”, and “Accessibility of Green Space”are selected as evaluation indicators.

Under the criteria of “promoting elements of space and environment close to nature”, preliminary identification of “the richness of vegetation”, “color of vegetation”, “aroma of vegetation”, “form of vegetation”, “waterscape compatible with vegetation” The five main categories under the core issue are served as indicators under the criteria layer.

Under the criteria of “Promoting the elements of space environment for social interaction”, the three main categories of “comfortable recreational facilities”, “appropriate vegetation volume” and “land of horticultural activities” were initially identified as indicators under the guidelines.

3.2 Revision of the evaluation index system based on fuzzy Delphi

3.2.1 Amendment to improve the evaluation indicators under the criteria layer of outdoor activities
Through the quantitative statistics of the expert fuzzy evaluation results, the retention and deletion results of the indicators under this level should be shown in Table 2.

At the stage of revision and improvement of various indicators at this level, some experts pointed out that due to the regional nature of the cold regions, the consideration of the microclimate of the space environment should be increased at this level, so the appropriate microclimate environment should be added. This indicator highlight the consideration of the microclimate factors in the green space of rural gardens in the cold areas.

For the correction and improvement of the first round of questionnaires, it is recommended that “The facilities for assisting the courtyard activities”, “Diversified types of courtyard green spaces”, “High-quality pedestrian pavements”, “Sufficient courtyard lighting”, “Green space accessibility” are revised to "Auxiliary facilities for courtyard activities", "Diversified garden greening types", "Safe and high quality walking paving", "Appropriate courtyard sunlight and lighting", "Accessibility to space" And increase the "Appropriate microclimate environment".The results of the second round of questionnaires were collated. Experts unanimously stated that the “Appropriate microclimate environment” should be retained. Some experts indicated that the index names under this level should be consistent with the other levels of representation, so it is recommended to remove the modifiers. .The revised results are “Safety facilities for courtyard activities”, “Diversity of green space functions”, “Walking paving”, “Court sunshine and lighting”, “Space accessibility” and “Microclimate environment”.The results of the third round of questionnaires were counted, and the expert group had no objection to the revised indicators.

Table 2.Importance of rural residential courtyard green space evaluation index for promoting outdoor activities

Criteria layer	Indicator layer	Importance	Whether deletion
Elemental environment elements for promoting the outdoor activities of cold and rural areas	Auxiliary courtyard activities	4.328	NO
	Diverse garden green space types	4.322	NO
	High quality pedestrian pavement	4.228	NO
	Sufficient courtyard lighting	4.106	NO
	Green space can be convenient	4.117	NO

3.2.2 Amendment to improve the evaluation indicators under the close natural criteria Through the quantitative statistics of the fuzzy evaluation results of the expert questionnaire, the retention and deletion results of the indicators under this level should be shown in Table 3.

The results of the first round of expert questionnaires were collated, suggesting that "The richness of vegetation", "The color of vegetation", "The aroma of vegetation", and "The waterscape that fits the vegetation" should be revised to "Diversity of vegetation", " The hue of vegetation", "The smell of vegetation", and "The appropriate courtyard water landscape".The results of the second round of questionnaires were collated. Some experts indicated that the "Appropriate courtyard water landscape" at this level should be consistent with the wording of the remaining indicators, so it was revised to "Garden water landscape", the first round needs to be determined. Whether the three indicators retained should be fully retained after the second round of expert group discussions.The results of the third round of the questionnaire were counted, and the expert group had no objection to the revised indicators.

Table 3.Promotes the importance of the evaluation index of green space in rural residential courtyards close to nature

Criteria layer	Indicator layer	Importance	Whether deletion
Promote the environmental elements of green space in rural areas where the elderly are close to nature	Vegetation richness	4.322	NO
	Vegetation color	3.978	Pending discussion
	Aroma emitted by vegetation	3.878	Pending discussion
	Vegetation form	4.089	NO
	Waterscape that fits with the vegetation	3.877	Pending discussion

3.2.3 Amendment of the evaluation indicators under the social interaction criterions The results of the retention and deletion of indicators at this level should be shown in Table 4 by statistics on the results of the questionnaire.

The results of the first round of questionnaires were sorted out, and there were no objections to the three indicators of "Comfortable rest facilities", "Appropriate vegetation volume" and "Land of gardening activities".The results of the second round of questionnaires were collated. Some experts indicated that the "Comfortable rest facilities" at this level should be consistent with the rest of the hierarchy, so it was revised to "Courtyard recreation facilities", "The volume of vegetation".The third round of questionnaires has no objection to the indicators.

Table 4.Importance of rural residential courtyard green space evaluation indicators to promote social interaction

Criteria layer	Indicator layer	Importance	Whether deletion
The elements of green space environment for the healthy and suitable old houses in the cold areas	Comfortable rest facilities	4.377	NO
	Suitable vegetation volume	4.011	NO
	Gardening venue	4.250	NO

3.3 Establishment of the evaluation index system Based on the ICF evaluation framework, using the preliminary selection of the evaluation indicators of the grounded theory and the fuzzy Delphi method of the expert group multiple rounds of correction, the formation of rural areas of the rural healthy and suitable home greening evaluation index system is constructed. The formation of the evaluation system is shown in Figure 2

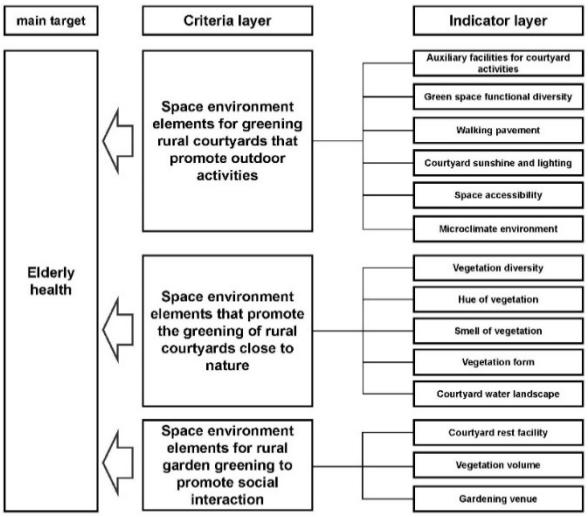


Figure 2. Corrected evaluation index system for greening and healthy old houses in cold regions

4. Decision making and integration of indicator weights

4.1 Decision process for evaluating indicator weights The process of calculating the weights of indicators in the indicator system by using the analytic hierarchy process is mainly divided into three stages. The first stage: the relative weight of the pairwise comparison indicators under the criterion layer, obtaining a matrix of n*n, where n represents the number of indicators participating in the weight assignment; The second stage: the consistency of the logic weight assignment of the C.I. and C.R. test experts, where C.I.=(λmax-n)/(n-1), the largest eigenvalue in the λmax matrix. C.R. = C.I./ R.I., the value of R.I. is related to n. When the comparison values of C.I. and C.R. are both less than 0.1, the weight assignment is verified by consistency; The third stage: using the largest normalized feature vector as the local weight of each indicator. The global weight of each indicator can be calculated by multiplying the weight coefficient of each criterion layer and the local weight of each evaluation index, and the global weighting degree is sorted.

4.2 Integration of evaluation index weight assignment results

4.2.1 Evaluation index weighting under the outdoor activity criteria For the results of the weight assignment results of the evaluation criteria for promoting the outdoor activity criteria layer and the evaluation indicators below, the results of the weights are shown in Table 5. The coefficient of the consistency verification ratio, Overall Inconsistency, is less than 0.1, the weight result is verified.

Table 5. Promoting the weighting of evaluation indicators under the criteria layer of promoting outdoor activity

Criteria layer	Indicator layer	Criterion weight	Local weight
Elemental environment elements for promoting the outdoor activities of cold and rural areas	Safety facilities for courtyard activities	0.358	0.204
	Green space functional diversity		0.174
	Courtyard walk pavement		0.108
	Courtyard sunshine and lighting		0.233
	Space-accessibility		0.126
	Microclimate environment		0.155

4.2.2 Evaluation index weighting under the close natural criteria For the results of the weight assignment results of the evaluation index that promotes the close natural criterion layer and the evaluation index below, the results of the weights are shown in Table 6. The coefficient of the consistency verification ratio, Overall Inconsistency, is less than 0.1, the weight result is verified.

Table 6.Promoting the weighting of evaluation indicators under the criteria layer of closing natural criterion

Criteria layer	Indicator layer	Criterion weight	Local weight
Promote the environmental elements of green space in rural areas where the elderly are close to nature	Vegetation diversity	0.392	0.353
	Hue of vegetation		0.134
	Smell of vegetation		0.161
	Vegetation form		0.250
	Courtyard water landscape		0.097

4.2.3 Evaluation index weighting under the social interaction criteria For the statistics of the weight assignment results of the evaluation criteria for promoting social interaction and the evaluation indicators under it, the results of weights are shown in Table 7. The coefficient of the consistency verification ratio, Overall Inconsistency, is less than 0.1, the weight result is verified.

Table 7. Promoting the weighting of evaluation indicators under the criteria layer of social interaction

Criteria layer	Indicator layer	Criterion weight	Local weight
The elements of green space environment for the healthy and suitable old houses in the cold areas	Courtyard rest facility	0.250	0.433
	Vegetation volume		0.158
	Gardening venue		0.409

4.3 Determination of the weight of evaluation indicators

4.3.1 Sorting and adjusting the index weights under the criterion layer Through the analytic hierarchy process, the local weights are assigned to the indicators under the criterion layers. The weighting coefficient of the criterion layer under the criterion layer of the green space environment elements for promoting the outdoor activities of the rural areas is 0.358.

The order of the local weights of the indicators under the criteria layer is: “Courtyard sunshine and lighting”, “Safety facilities for courtyard activities”, “Green space functional diversity”, “Microclimate environment”, “Accessibility of space” ", “Courtyard walk pavement." The weight sorting results are shown in Table 8.

Table 8. Ranking of the weights of evaluation indicators under the criteria layer of promoting outdoor activity

Indicator layer	Local weight of indicator	Weight sort
Safety facilities for courtyard activities	0.204	2
Green space functional diversity	0.174	3
Courtyard walk pavement	0.108	6
Courtyard sunshine and lighting	0.233	1
Space-accessibility	0.126	5
Microclimate environment	0.155	4

The weight coefficient of the criterion layer under the criterion of promoting the green space environment elements of the healthy and suitable old houses in the natural village is 0.392. The order of the local weights of the indicators under the criterion layer is: “Vegetation diversity”, “Vegetation shape”, “Vegetation smell ”,“The hue of vegetation”, “Courtyard water landscape”. The weight sorting results are shown in Table 9.

Table 9. Ranking of the weights of evaluation indicators under the criteria layer level of closing to nature

Indicator layer	Local weight of indicator	Weight sort
Vegetation diversity	0.353	1
Hue of vegetation	0.134	4
Smell of vegetation	0.161	3
Vegetation form	0.250	2
Courtyard water landscape	0.097	5

The weighting factor of the criterion layer under the criterion of promoting the green space environment elements of the healthy and suitable old houses in the natural village is 0.250. The order of the local weights of the indicators under the criterion level is: “Courtyard rest facilities”, “Horticultural activities”, “Vegetation volume”.

Table10. Ranking of the weights of evaluation indicators under the criteria layer level of social interaction

Indicator layer	Local weight of indicator	Weight sort
Courtyard rest facility	0.433	1
Vegetation volume	0.158	3
Gardening venue	0.409	2

4.3.2 Sorting and adjusting under the weight of global indicators Through the statistics of the calculation results of the criterion weight coefficient and the local weight assignment, the importance of each evaluation index on the health of the elderly in the cold rural areas is shown. The global weight sorting results are shown in Table 11.

Table 11.Ranking results of global weights of evaluation indicators

Criteria layer/index layer	Weights	
	Global weight	Sort
Safety facilities for courtyard activities	0.080	3
Green space functional diversity	0.059	7
Courtyard walk pavement	0.042	13
Courtyard sunshine and lighting	0.077	4
Space accessibility	0.049	12
Microclimate environment	0.052	11
Vegetation diversity	0.140	1
Hue of vegetation	0.057	8
Smell of vegetation	0.084	2
Vegetation form	0.075	5
Courtyard water landscape	0.036	14
Courtyard rest facility	0.055	9
Vegetation volume	0.074	6
Gardening venue	0.053	10

4.3.3 Comparison and discussion of index weight results Through the expert perspective on the results of the local weight assignment under the criterion layer, and in the evaluation indicators under the criterion layer for promoting outdoor activities, “Garden sunshine and lighting” is the most important for the health promotion of the elderly in the cold area, and the criterion for promoting closeness to nature. Among the evaluation indicators under the layer, the “Diversity of vegetation” plays an important role. In view of the evaluation results of the local weights of the evaluation indicators which under the criterion of social interaction, the “Courtyard recreation facilities” promotes the health of the elderly in the cold. More important, from the statistics and ranking results of the global weights, the “Vegetation diversity” is the most prominent, and the “Courtyard water landscape” is the weakest.

Table 12.Comparison of local weights and global weights

Criteria layer/index layer	Weight sort	
	Local weight ordering	Global weight ordering
Safety facilities for courtyard activities	2	3
Green space functional diversity	3	7
Courtyard walk pavement	6	13
Courtyard sunshine and lighting	1	4
Space accessibility	5	12
Microclimate environment	4	11
Vegetation diversity	1	1
Hue of vegetation	4	8
Smell of vegetation	3	2
Vegetation form	2	5
Courtyard water landscape	5	14
Courtyard rest facility	1	9
Vegetation volume	3	6
Gardening venue	2	10

It is not difficult to see from the statistical results of local weight and global weight. Under the influence of the weight coefficient of the criterion layer, the global weight of the evaluation index is more effective to show the effect of the evaluation index on the health promotion of the elderly in the cold rural areas. The local weight is an effective feedback to the evaluation level of the criterion layer. Multi-dimensional weight assignment is more systematic than the weight assignment of a single pairwise comparison. The process of decision-making is more systematically reflected, and the interaction between each evaluation index and the criterion layer and the target layer is more systematically reflected. It has important reference value for improving the green space of healthy and suitable old houses in rural areas.

5. Conclusions and prospects

According to the results of the expert's weight decision-making, the most important evaluation index is the “Vegetation diversity” in the evaluation index of the healthy and suitable residential garden greening in the cold rural areas. The lowest important evaluation index is “Garden water landscape”. The ranking of the global weights of the remaining evaluation indicators is: “Smell of vegetation”, “Safety facilities for courtyard activities”, “Garden sunshine and lighting”, “Form of vegetation”, “Physical volume of vegetation”, “Multiple functions of green space” ,“Hue of vegetation”, “Courtyard rest facilities”, “Gardening activities venue”, “Micro-climate environment”, “Space accessibility”, “Courtyard walk pavement”. Compared with the weight decision results of a single level, the assignment and ranking of local weights and global weights are more comprehensive and the system's important role in each evaluation index is clearly feedback.

Through the construction, revision, and weight decision-making stage, the evaluation index system for the healthy for the elderly houses in the cold rural areas provides an effective reference for the assessment and improvement of the rural residential courtyard green space under the perspective of

healthy for the elderly, but it should also be on the basis of the existing research, the specific measures for improving the evaluation indicators are further explored. At the same time, because the cold regions have regional specificities, the research objects of this paper will be affected to some extent, and further indepth discussion will be made to broaden their regional restrictions.

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