



Research Paper

## Landscape Ecology Theory: Research on the Mechanism of Rural Design in Jinshan District, Shanghai—— Based on Qualitative Comparative Analysis (QCA) method

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**Abstract:** *[Purpose/Significance]* In the new era of building a better life, Art rural construction research is very hot, the academic circle has paid full attention to the design mode of rural public space, but the lack of multi-factor research on the rural design. Rural design considers people's participation and evaluation. *[method/process]* this paper will rural public space design as a multi-factor coupling design process, with 175 Shanghai Jin Shan district rural designs as a sample, from the visual beauty, smell, and tactile psychological sensing three dimensions, according to the scene ecology, selected the visual beauty, sound, taste, smell, touch, and psychological sensing in six factors as condition variables, using qualitative comparative analysis method, analyzes the factors affecting rural design. *[Results/Conclusion]* It is found that under the background of rural revitalization in the new era, the deep logic of rural design is in a multi-factor coupling form, and this paper provides a systematic and feasible design strategy for rural design.

**[Key words]** Rural design; mechanism research; landscape ecological theory; QCA method

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### I. Introduction

Today's society is in a period of rapid development of economy and science and technology. Through a large number of literature and research on many rural revitalization design projects, the difference in people's acceptance of rural design is great. There are great differences in the design and evaluation of many rural design and reconstruction projects. In the context of rural revitalization in China, the practical needs of sustainable development urgently need us to carry out the evaluation system of rural design and its related research.

With Jiangnan culture as its characteristics, we will explore the harmonious coexistence of rural construction, public services, and local civilization, and conform to the rural people's yearning for a better life.

Positioning, optimizing spatial layout, clear theme image, innovating local products and other paths to carry out comprehensive planning and renovation of the village area, rural cultural brand building, and steadily promoting the development requirements of "see the mountains, see the water, and remember the homesickness.(Xinqun Feng,2021)<sup>1</sup>

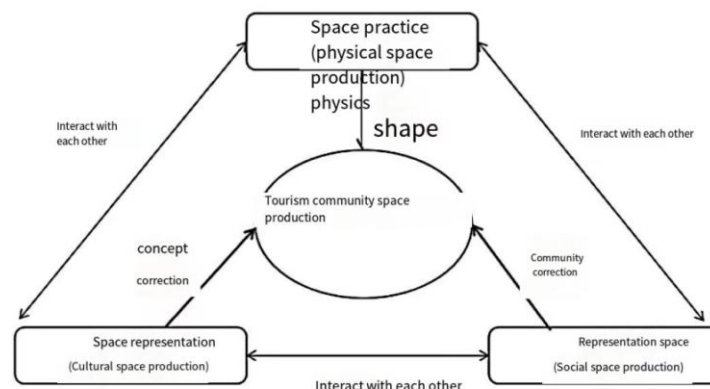
Most countries and regions have no specific standards for public activity space.<sup>2</sup>Based on the ecological theory of landscape sense (Land senses Ecology), this study uses the configuration thinking of qualitative comparative analysis to construct the evaluation system, aiming to explore the action mechanism and complex logic of multiple concurrent factors embedded under the influence of landscape sense relationship on rural design. According to the three groups of designers, expert groups, villagers ,and village representatives, the satisfaction of different elements of rural design cases and the importance of these elements are evaluated, and the configuration relationship affecting the sense of landscape ecological construction of rural design is studied.

## II. Literature Review And Model Building

### 2.1. The multidimensional complexity of the countryside itself

The concept of rural design is based on the system of design, sociology, ecology, rural design is a complex system of many factors, the corresponding country is constantly in the process of evolution development, in addition to the physical dimension has a bearing effect on spatial properties, through the analysis of the 1974 "space production" French scholars in the foot of space methodology, by introducing selective others to dissolve the traditional binary opposition thinking mode.

Based on the analysis of villages based on ternary spatial methodology, the three attributes of villages are rural practice, rural representation ,and rural representation.Therural area is not only the material space production as a place of life and practice, but also the cultural space production as a carrier of values, and also the social space production as an interpersonal link.(Hua Zhang et al., 2021) The complexity of the countryside can be seen.



1Figure 1 Space governance path of the rural tourism community

<sup>1</sup>XinqunFeng: "Presence" and "Camp structure" —— design speculation and multiple evolution in the context of the new era [J].Design, 2021,34 (22): 46-53.

<sup>2</sup>Villanueva K,Badland H, Hooper P, Kooh Sari MJ, Mavoia S, Davern M, Rob Ertz R, Goldfeld S, Giles -Corti B.developing Indicators of public Open space to promote health and wellbeing I N Communities.Applied Geography, 2015, 57:112-119.

(Photo source: Hua Zhang et al., 2021)

## 2.2. The complexity of the correlation of various elements of artistic intervention

In the existing studies, a large number of articles have been found to make a descriptive analysis of the survey data, or to make case analyses of individual rural water cases. This paper hopes to combine the two to explain the theoretical root of the systematic difference, and verify the interpretation with practical evidence. Studying the reasons and mechanism behind the difference in rural design project evaluation is the research focus of this paper.

Due to the complexity of art in the correlation between the elements of rural design, this paper focuses on the various perceptual needs of human beings for rural design, and presents the landscape of the human five senses into visual elements, auditory elements, taste elements, olfactory elements, tactile elements, and psychological sensing elements.

**Table 1.** Planning content and method based on the concept of landscape ecology

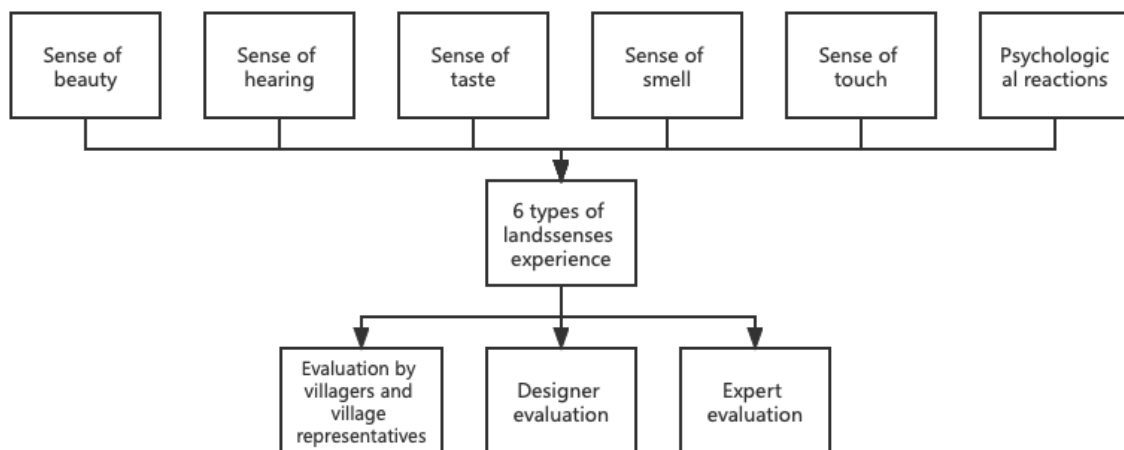
Sense type	Sense organ	Planning category	Planning content and method
		Landscape pattern	Landscape pattern optimization
		architectural style	Architectural color planning
		Plant landscaping	Plant configuration design
Sense of beauty	eye	cultural heritage	Protection of ancient buildings and houses
		Education and publicity	Wu science and technology presentation
		Environmental protection	Water surface cleaning, garbage ,and solid waste treatment
		luminous environment	Glass Curtain Wall and Night Lighting Design
		noise control	Greening isolation belt design
Sense of hearing	ear	Natural sound construction	Construction of natural sound landscape such as springs, waterfalls ,and frogs
		Recreation	Peasant-style catering entertainment
Sense of taste	mouth	Agricultural landscape	Picking agriculture, modern agriculture
		Scenic spot configuration	Design of ecosystem supply service
		Plant configuration	Pro-soil breath design
Sense of smell	nose	rare delicacy	Flower-loving configuration
		Smelly water treatment	Hydrophilic design
Sense of touch	skin	Building material	Experience design, hydrophilic design
	arms and legs	Trail design	Slow system
Sense of wind	skin	microclimate	Ventilation corridor

		humiture	visibility
		reachability	Green corridor pattern
		Perspective	Scene awareness
<b>Psychological reactions</b>	heart	traditional culture	cultural identity
		Sense of holiness	Huangcheng culture
		sense of security	Landscape color
<b>Direction sense</b>	cerebrum	Landmark building	Symbol, landscape sculpture
		Visual axis	Visual axis design

(Data source: Shi Longyu et al., 2017)

### 2.3. Research framework construction

This study tries to build the framework of rural design based on the original research on landscape ecology. The six types are visual beauty, sound, taste, smell, touch, and psychological sensing.



2Figure 2 Theoretical framework of landscape sense evaluation system in rural design

Visual elements: the most basic components of rural design.<sup>3</sup>Its basic characteristics and sub-planning categories include seven categories: landscape pattern, architectural style, plant landscape, cultural heritage, education and publicity, environmental protection, and light environment. The visual elements of its rural design projects are judged by comparing the internal logic changes of the sub-categories.

Sound sense elements: the sense is the ear, the planning categories include: noise control, and natural sound construction. The planning content is green isolation belt design; spring, waterfall, frog ,and other natural sound landscape construction.

<sup>3</sup>Shi Longyu, Zhao Huibing, Zheng Shuanning, Yu Tianshu, Dong Rencai. Basic ideas and realization of ecological planning [J]. Journal of Ecology, 2017, 37 (06): 2126-2133.

Taste elements: sensory is the mouth, planning categories are recreation and entertainment, agricultural landscape, scenic spot configuration. Planning content: rural catering and entertainment; picking agriculture, modern agriculture; ecosystem supply service design.

Sniff sense elements: sensory is the nose, planning categories are plant configuration, odor, smelly water treatment. Planning content: earth-earthy design; floral configuration; hydrophilic design.

Tactile: elements: sensory is skin | limbs, planning category: trail design, building material. Planning content: chronic system; site experience design, hydrophilic design.

Heart sensing elements: senses are the heart, planning categories are: accessibility, perspective, security, traditional culture, and sense of holiness. Planning content: green corridor pattern; scene awareness; landscape color; cultural identity; imperial city culture.

The theory of the experimental conjecture: rural design of landscape elements of different combination of a different aesthetic experience, which lead to the rural design project aesthetic experience difference, through expert evaluation, designer evaluation ,and villagers, the village represents three different groups of rural design elements of aesthetic preference and can deduce from bottom to up the evaluation of the difference of rural design project.

Research conception of this experiment: through the existing studies or to make a descriptive analysis of the survey data, or to evaluate the individual rural design cases. This paper hopes to systematically explain the theoretical root causes of the differences in the evaluation of aesthetic experience in rural design, and verify and explain them with data.

The artistic elements of evaluating rural design are very complex. Based on the multiple factors such as rural characteristics, cognitive differences of evaluation subjects, and design presentation differences, the people's evaluation of rural design projects. This paper mainly studies the last element, namely, how the difference in rural design presentation effect leads to the difference in aesthetic experience of rural design projects.

### III. Research technique

#### 3.1. Qualitative and comparative analysis

Qualitative comparative analysis of social science methodology QCA (Qualitative Comparative Analysis) is between qualitative analysis (case-oriented) and quantitative research (variable oriented), based on the boolean algebra mathematical set theory configuration analysis method, its basic idea is to abstract the problem for the set of conditional variables and result conditions, analyze the combination of conditional variables how to lead to the occurrence of specific results. There is clear set (csQCA), multivalued set (mvQCA), fuzzy set (fsQCA), and the fsQCA used in this article. The study step is calibration data-generating value table-analysis.

For rural design, the relationship between the landscape elements is organically unified, suitable for logical relationships. The focus of this paper is not the analysis of individual rural design cases, but the systematic induction of several rural design projects.

Table 2: Variable Definition and Measurement

type			Measurement index
outcome variable	View ecology	JGST	The ranking and score of "the second I am Village Landscape Competition"
condition	cultural heritage	whyc	Architectural architectural design with historical features

variable	landscape pattern	jggj	Rural axis, road network, water network layout design
	Natural ecology	zrst	Create a natural ecological and circular environment
	Smelly water treatment	cscl	Oant water treatment, floral configuration, earthy flavor design
	Waterfront landscape	bsjg	Hydrophilic design, waterfront landscape natural landscape design
	Facility for the elderly	slss	A Chronic system, suitable facilities for aging optimization
	Building material	jzcl	Use rural localization materials
	cultural inheritance	whcc	Rural classroom, aesthetic education dissemination

In this study, the conditional variables were the preliminary investigation in the form of a semi-structured interviews, and then the measurement indicators and item design Likert scale were set. The respondents were divided into three groups: expert evaluation, designer evaluation ,and villagers and village representatives. The winning design works were scored in the form of the questionnaire, and weighted average by entropy method respectively to obtain the final score of each variable, and the variables of 90 or more were selected into the category of conditional variables of the optimal scene ecological solution (as shown in Table 2 above).

Table 3 The first prize list of the 2021 "I Plant Rural Landscape" Yangtze River Delta Youth Rural Revitalization Design Competition

number	class	selected topic	staff specialty	team members	The name of the work
1	Rural design category	Shengxin Village Youth Center is built	East China University Of Science	Ping Chengliang, Li Xinran, Zou Hanhan Yang Shihao, Qu Yupei, Fang oblique Ping	Dongfeng resurrection, happy to live sheng new
2		Xifang villager's village design	Donghua University Tongji University	Zhao Yantang, King of Peng Huang Ruiyu, Dai Jintao	Lead to the mountain
3	Local product design category	Fengjing "Jiufeng" agricultural products packaging design	Donghua University	Yu Zhenghe, Wu mix tamarix	Jiufeng agricultural fruit and vegetable gift box packaging design
4		Corridor of August fragrant rice packaging design	Shanghai Engineering Technology university	Qu Gaojin and Ma Jun Qi Weijia Tao Meng Zhu Mengya	Corridor under the August fragrant rice brand and packaging design

Sample scope: This paper targets 175 rural design projects with 30 design points (17 points in the rural design and 13 points in local product design points in the Jinshan District of Shanghai) as preliminary samples. After three rounds of evaluation, a total of 34 projects winning the first, second ,and third prizes were determined as the study, with half the rural design and local products.

Based on the landscape ecology, as mentioned above, there are many criteria to measure the involvement of the art in the rural design. The design projects are designed to more comprehensively measure and scientifically judge the beautiful countryside, as shown in Table 3 above, in 2021

The three rounds of evaluation and voting results of the "Yangtze River Delta Youth Rural Revitalization" Design Competition are based as the outcome variables of this study. Correct the original votes to unit votes.

### 3.2.QCA model setting

In the context of theQCA method, the conclusions are expressed by logical expression, upper letters indicate high configuration, lower case letters indicate non-high configuration, "+" indicates logic or, and "\*" indicates logic and.Its model setting: JGST=f 1 (whyc, jggj, zrst, cscl, bsjg, slss, jzcl, whcc), condition variables are a cultural heritage (whyc), landscape pattern (jggj), natural ecology (zrst), smelly water treatment (cscl), waterfront landscape (bsjg), aging facilities (slss), building materials (jzcl), cultural inheritance (whcc).The outcome variable was landscape ecology (JGST).

## IV. Empirical Analysis And Discussion

### 4.1 Variable calibration and threshold setting

According to the relative calibration method of QCA data, the fuzzy set calibration method. Set three thresholds for conditional variables and outcome variables, namely, cross-membership points and completely non-affiliation points, and set the critical points of the original data as 95%, 24% ,and 5%, and then convert the set membership into 0 to 1 through QCA software, as shown in the variable calibration in Table 4.

variable	whyc	jggj	zrst	cscl	bsjg	slss	jzcl	whcc	JGST
Not subordinate at all	4	3	3	2	3	3	3	3	27
cross point	4.8	4	4	3.8	4	4	3.8	3.8	31.8
Fully subordinate	5	5	5	5	5	5	5	5	39

2Table 2: Variable calibration

### 4.2 analysis of necessity

In this study, the necessity analysis of the conditional variables was conducted based on the QCA research manual to verify whether all individual conditions are necessary for the optimal scene sense ecology. From the perspective of set theory, the necessary test for a single condition is to analyze whether the set of results constitutes a subset of the set of conditions. In the process of empirical test, if a condition variable always exists when the result is produced, then the condition variable is a necessary condition to lead to the result. The consistency index is an important standard to test the necessary conditions. When the consistency level is greater than 0.9, then the condition is the necessary condition for the results (Du Yunzhou, Jia Liangding, 2017).

	WHYC	JGGJ	ZRST	CSCL	BSJG	SLSS	JZCL	WHCC
consistency	0.857143	0.767690	0.931242	0.955274	0.865154	0.936582	0.848465	0.781041
coverage	0.831068	0.871212	0.933110	0.939593	0.864000	0.911039	0.899505	0.809129

3Table 3 Necessity analysis of individual conditional elements

The analysis results in Table 5 show that the consistency of 3 indicators out of the 8 variables exceeded 0.9, namely ZRST, CSCL, and SLSS, that is, the necessary conditions in this study. Through further analysis of the combined effect of each condition variable, the configuration relationship of multiple factors and multiple variables was obtained.

#### 4.3 Configuration analysis

$$Slss * (Cscl * Bsjg * Whyc) + Jzcl * Zrst * Jggj \quad (Cscl * Bsjg * Whyc) + Slss * Jzcl * Zrst * Jggj \quad (Cscl * Bsjg * Whyc) = JGST$$

Condition Combination Path 1: (Slss \* Bsjg \* Cscl \* Whyc)

Condition Combination Path 2: (Jzcl \* Bsjg \* Cscl \* Zrst \* Jggj \* Whyc)

Condition Combination Path III: (Whcc \* Jzcl \* Slss \* Bsjg \* Cscl \* Zrst \* Jggj)

Conformation analysis can find the core conditions and edge conditions (or auxiliary conditions) in the configuration. The core condition in the configuration is the condition variable that has a strong causal relationship with the outcome; while the edge condition (or the auxiliary condition) has a weak causal relationship with the outcome variable. Optimization and simple solutions in qualitative comparative analysis using QCA. If a conditional variable appears in both a simple and optimized solution, if a condition variable appears only in an auxiliary or edge condition

In this study, the core condition and the edge condition were distinguished based on the simple solution (configuration 1) and the optimized solution (configuration 2). ● is expressed as the necessary condition, ○ represents the edge condition with a low score, and the blank is that the condition variable did not appear.

condition variable	Configuration expression:		
	Configuration 1:	Configuration 2:	Configuration 3:
	Slss * Bsjg * Cscl * Whyc	Jzcl * Bsjg * Cscl * Zrst * Jggj * Whcc * Jzcl * Slss * Bsjg * Cscl * Whyc	Zrst * Jggj
WHYC	○	○	
JGGJ		○	○
ZRST	●	●	●
CSCL	●	●	●
BSJG	○	○	○
SLSS	●	●	●



<b>JZCL</b>		○	○
<b>WHCC</b>			○
<b>Consistency</b>	0.957427	0.997347	1
<b>Coverage</b>	0.675568	0.502003	0.473298

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Condition configuration analysis is a condition combination of adequacy analysis, the test of conditional variables, due to the same result of condition variables have different combinations, so to deal with the low-reliability configuration and set the consistency of the results, and then select the unqualified configuration relationship, due to the study sample is different, the existing research consistency threshold is different. This study set consistency to 0.95, between the experimental sample size is moderate, the observation frequency is set to 1, can explain the consistency of optimal ecological solution is 0.95, said in all meet the two conditions of rural design case, 90% of the cases are optimal ecological, coverage exceeds 0.5, said that the two conditions configuration can explain more than 50% of the optimal ecological rural design case.

The robustness test step, adding the light environment to the optimal scene sense ecological configuration as a new conditional variable, and the resulting new results do not change our interpretation of the original results.

## V. Conclusion And Revelation

The longitudinal comparison is made between the rural design projects of the scenic landscape ecology, and the condition combination in the case of the scenic landscape ecology is cultural heritage, smelly water treatment, waterfront landscape ,and suitable facilities. According to the principle of taking the intermediate solution in the QCA experiment, the condition combination in configuration 2 is analyzed, namely cultural heritage, landscape pattern, natural ecology, smelly water treatment, waterfront landscape ,and building material. In theory, there is an alternative relationship between the two paths, including some projects in reality.

Its internal mechanism is not only the joint perception effect of aesthetic experience but also the local factors caused by the geographical environment of Shanghai Jinshan. There are great differences between design groups and non-design groups, and the evaluation of non-design professionals is less affected by building material, landscape patterns, and other elements, which is reflected in the assumption of the experimental model. The lay group is significantly more sensitive to aging facilities and smelly water treatment than the professional group, and both the configuration results and the case analysis support this conclusion, and this difference is reflected in the empirical results. Analysis of the reasons for the aging facilities are in line with the current situation of empty-nest aging in Jinshan countryside, and the intuitive feedback of smelly water treatment is strong, which has a great impact on the aesthetic experience of the masses.

Based on case knowledge and configuration analysis, this study constructed the conditional configuration of excellent landscape ecology and the empirical interpretation of professional and non-professional rural design evaluation and specifically discusses the reasons and mechanisms of this difference, which is the marginal contribution of this study. There are also some limitations to this study. For example, there is still room for improvement in the measurement of natural ecology and other elements. Only the village points in Jinshan District where the 34 projects with high scores in the rural design competition were selected as the research area, and the empirical explanation constructed in this paper is still not complete. We look forward to furthering future research to continue to explore the reasons and mechanisms affecting the ecological ecology of rural design from different perspectives.

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