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Selection of Urban Style and Features of Haixi Prefecture Based on Cluster Analysis

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Abstract:

The accelerated urbanization has led to increasingly prominent problems such as seriously convergent urban style and inadequate features. Based on 3 types of targets and 11 types of elements, a town style index system is constructed, and quantitative analysis method combining descriptive, principal component and clustering is taken to investigate the common and distinctive features of 22 towns and cities in Haixi Prefecture, so that style and features can be selected for each town. The analysis results indicate that urban style and features of Haixi Prefecture are manifested in the two primary aspects of natural and artificial elements, but humanistic element is insufficient. Where, the style and features of 9 towns are dominated by natural elements, that of another 9 towns is dominated by artificial elements, and that of the remaining 4 towns is dominated by humanistic elements. Hence, attention should be given to the exploration of urban regional cultural elements in actual protection to provide an important support and reference for the inheritance and development of style and features.

Keywords: *Urban style, Feature selection, Principal component analysis, Cluster analysis*

I. INTRODUCTION

Urban style is the sum of the natural and cultural landscapes of a town and the connotations of the town's history, culture and social life behind it. It gives the most powerful and wonderful high-level generalization of a town [1, 2]. At present, as many Chinese cities and towns strengthen the management and control of style and features under the awakening awareness of reconstructing regional features, the selection and shaping of urban style and features has increasingly become the focus of architectural planning discipline. Feature selection is to differentiate the unique and typical urban style of a town based on perception [3].

Although domestic and foreign studies on urban style and features are desynchronized in terms of time and stage, the themes and content present basically the same evolution trends [4], experiencing connotation

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analysis of style and features [5, 6], construction of style and features system [7, 8] protection and control [9-11]. Seen from the domestic existing research, it is a research trend to adopt quantitative analysis methods like IPA [12], comprehensive analysis methods combining quantitative and qualitative analysis methods such as analytic hierarchy process [13] to evaluate the current urban style and features [14]. However, there is insufficient comparative research on the style and features of multiple towns within a certain area. In particular, selection of different style and features needs to be further explored. Most research areas are concentrated in the eastern and central developed cities [15], and there are relatively few studies on the west, especially urban style and features on the Qinghai-Tibet Plateau. In addition, in the practical process of planning, design, and construction, qualitative description methods such as induction and refinement are often used to select style and features [16], and quantitative methods are rarely used. Accordingly, it is necessary to construct a set of scientific quantitative research methods for determining and comparing urban style and features, summarize the common, unique features and deficiencies embodied by the towns of the same geographical unit in characteristic themes, which can provide powerful basis for inheriting and continuing the distinctive urban style and achieving characteristic urban development, thus demonstrating important practical guiding significance.

II. RESEARCH FRAMEWORK

2.1 Overview of the Study Area

Haixi Mongolian and Tibetan Autonomous Prefecture is located in the northwest of Qinghai Province, where, the plateau climate and the Qaidam Basin provide a natural environment in which salt lakes, deserts and grasslands coexist, resulting in sparse towns and populations. In addition, Nomhon's prehistoric culture, ancient "Silk Road" culture, Mongolian-Tibetan-Han multi-ethnic culture, etc. shape its multi-cultural background. The study selected 22 towns in Haixi Prefecture as research samples, as shown in Figure 1.

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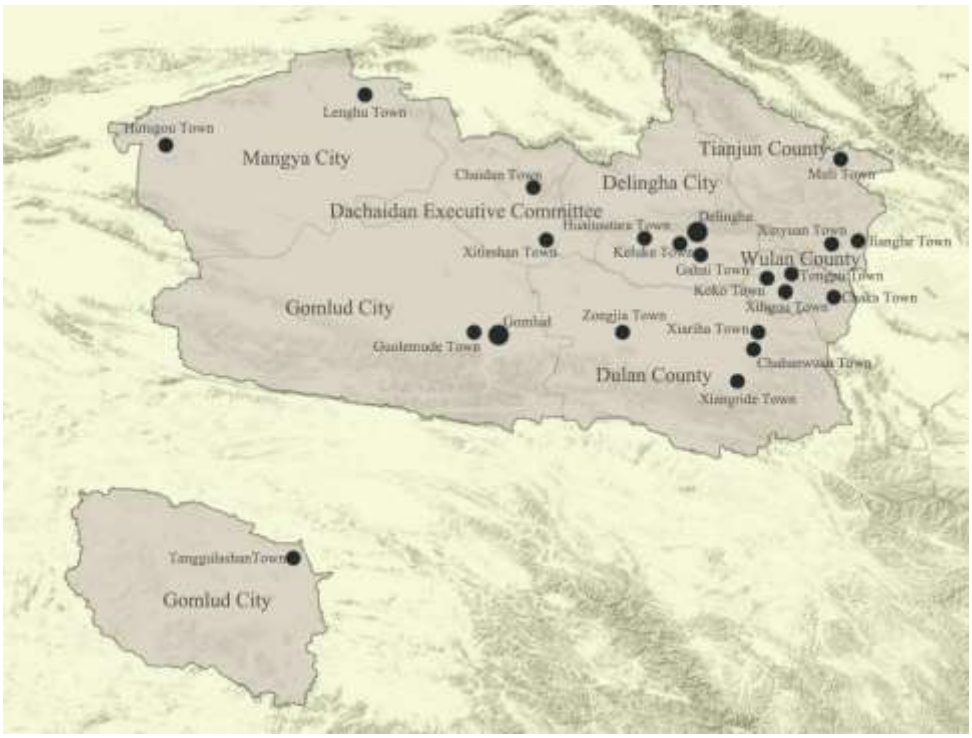

Figure 1: Research sample

2.2 Selection of Feature Indexes

The formation of urban style is mainly subjected to factors such as urban natural environment, historical accumulation, residents' life, urban spatial form, social economy [17]. Through literature research and field investigation, 22 feature indexes affecting urban style are determined, which belong to three aspects of natural environment style, built environment style, and historical and culture features. The 22 feature indexes are named p1, p2, ..., p22, as shown in Table I.

2.3 Research Methods

This paper follows the analysis idea of "macro-meso-micro", investigates individual characteristics on the basis of the commonality in regional urban style formation, constructs the selection index system for urban style and features, adopts quantitative analysis method combining descriptive analysis, principal component analysis and cluster analysis to discuss common and unique features of urban style and features of Haixi Prefecture, and then selects the urban style and features. First, through descriptive analysis, differential analysis was made on the style index data of 22 towns. Considering that indexes with small coefficient of variation (<40%), little dispersion, and close value distribution cannot reflect the significant differences in style between towns and cities, they are eliminated to better identify the style differences between cities and towns. Second, through principal component analysis, the data structure is simplified to convert the multi-dimensional indexes in the evaluation of urban style and features into a few linearly independent primary style and feature categories, so that the pros and cons of the urban style and features

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can be judged based on the principal component analysis scores. Furthermore, the principal component analysis scores are systematically clustered by connection and Euclidean square distance to understand the categories of towns with different style and features. Finally, by comprehensively considering the calculation results of descriptive analysis, principal component analysis, cluster analysis, urban style and features are selected. The method and idea is shown in Figure 2.

2.4 Data Sources and Processing

Among the data, the statistical data derives from the statistical bulletins of cities and counties in Haixi Prefecture; the measurement data derives from on-the-spot measurement and Google satellite image measurement analysis; other index data difficult to calculate is collected by 45 experts (Haixi Prefecture government management personnel, urban planning practitioners) through distribution of score sheet (45 copies are all valid and returned). IBM SPSS Statistics 24 was used for descriptive analysis, principal component analysis, and cluster analysis of data processing. Where, the natural environment style, historical and culture features take the administrative scope of towns as the research scope, while the built environment style takes the central city (town) area as the research scope.

TABLE I. The selection index system of urban style and features

Target	Element	Index code	index	Index measure
Natural environment style	Mountain body	p_1	Distance between mountain and town center (km)	Numerical calculation
		p_2	mountain height (m)	Numerical calculation
		p_3	Mountain landscape	Graded evaluation
	Water body	p4	Distance between river and lake and town center (km)	Graded evaluation
		p5	Landscape of rivers and lakes	Graded evaluation
		p6	River seasonality	Numerical statistics
	Green	p7	Greening coverage (%)	Numerical statistics
	Climate	P8	Annual average temperature (℃)	Numerical statistics
		P9	Annual average precipitation (ml)	Numerical statistics
Built environment style	Space form	p10	Town morphological saturation coefficient	Numerical calculation
		p11	Town aspect ratio	Numerical calculation
	Street space	p12	Height width ratio of Main Street	Numerical calculation
		p13	Coverage of main street facilities (%)	Numerical calculation
	Landmark	p14	Identifiable degree of entrance and exit	Graded evaluation
		p15	Number of markers (number)	Numerical statistics
	Public space	p16	Square area (km^2)	Numerical calculation
		p17	Square landscape	Graded evaluation
	Architecture	p18	Architectural style and regional characteristics	Graded evaluation

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		P19	Harmonious degree of architectural color	Graded evaluation
Historical and cultural features	Historical and Cultural protection	p20	Number of cultural relics protection sites (number)	Numerical statistics
		p21	Level of cultural relics protection unit	Numerical statistics
	Folk culture inheritance	p22	Continuity of traditional living habits	Graded evaluation

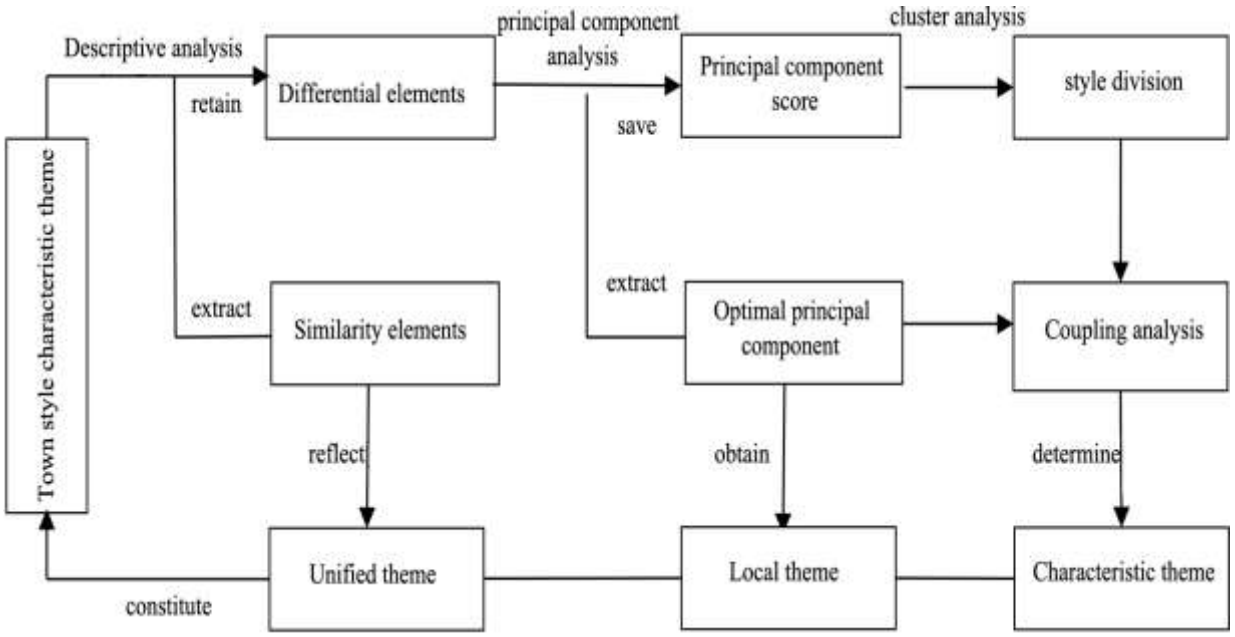

Figure 2: Method and idea

III. RESEARCH PROCESS

3.1 Descriptive Analysis

A descriptive analysis was performed on 22 style and features data of 22 towns and cities in Haixi Prefecture, with the results shown in Table II. Where, the six indexes of landscape of rivers and lakes, river seasonality, greening coverage, harmonious degree of architectural color, square landscape, and town morphological saturation coefficient have a coefficient of variation less than 40%, with small dispersion and relatively close value distribution. These six indexes do not display significant differences between cities and towns. The other 16 indexes have greater coefficients of variation, which suggests that different towns are quite different in most style index. Annual average temperature has a coefficient of variation of 270.1%, with great data dispersion and great difference between towns in the measured index values, which has relation with the geographical location and altitude of each town. The distance between mountain and town center, distance between river and lake and town center also has a great coefficient of variation, which has relation with suitability of towns and cities in site selection, as shown in Figure 1.

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TABLE II. Descriptive statistics of urban style and features

	Number of cases	Range	average value	standard deviation	Coefficient of variation
Distance between mountain and town center	22	20.82	4.0945	4.93640	1.206
mountain height	22	1620.00	534.3182	459.21853	0.859
Mountain landscape	22	32.71	21.4032	8.64690	0.404
Distance between river and lake and town center	22	39.64	5.5273	9.12855	1.652
Landscape of rivers and lakes	22	33.67	26.1382	8.20636	0.314
River seasonality	22	33.86	28.9118	8.42352	0.291
Greening coverage	22	35.70	26.4691	9.04313	0.342
Annual average temperature	22	8.50	1.2295	3.32210	2.702
Annual average precipitation	22	457.50	175.2364	105.52227	0.602
Town morphological saturation coefficient	22	0.66	0.4645	0.17251	0.371
Town aspect ratio	22	3.12	1.5875	0.73415	0.462
Height width ratio of Main Street	22	0.60	0.3536	0.15704	0.444
Coverage of main street facilities	22	78.00	52.8636	25.49378	0.482
Identifiable degree of entrance and exit	22	30.08	17.4305	9.00160	0.516
Number of markers	22	5.00	2.8636	1.42413	0.497
Square landscape	22	22.00	21.3286	6.76269	0.317
Square area	22	23.13	3.7927	5.78192	1.524
Architectural style and regional characteristics	22	26.46	19.1932	8.22334	0.428
Harmonious degree of architectural color	22	25.49	22.0623	6.70241	0.304
Number of cultural relics protection sites	22	37.00	10.1818	11.16387	1.096
Level of cultural relics protection unit	22	53.00	12.1818	14.12069	1.159
Continuity of traditional living habits	22	31.51	19.2086	9.01267	0.469

The descriptive analysis indicates minor differences between factors such as landscape of rivers and lakes, river seasonality, greening coverage, harmonious degree of architectural color, square landscape, and town morphological saturation coefficient, which reflects from the other side the overall similarity of Haxi style and common urban features in the region known for its "surrounding by mountains and basins, the source of rivers and lakes", "Qinghai-Tibet thoroughfare, sparse towns", "multiculture and ethnic integration". Located in the Qaidam Basin, it is widely distributed with salt lakes and dominant by seasonal rivers. The towns are small in scale, mostly located in areas with abundant water sources, convenient transportation and rich resources. The relatively backward economic development results in insufficient urban development control, so the harmonious degree of architectural color is low, and the overall style is inconspicuous.

3.2 Principal Component Analysis

3.2.1 Data verification

The KMO and Bartlett tests were performed on the collected index system data, with test results shown in Table III. The KMO test value is 0.563, greater than 0.5 (due to the small number of research samples and abundant indexes, KMO<0.6), and the Bartlett sphericity test has a statistical significance probability $p = 0.000 < 0.005$. The results suggest that the data structure validity is ideal, variables are correlated, and principal component analysis is applicable.

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TABLE III. KMO and Bartlett test

Kmo sampling suitability quantity		0.563
Bartlett sphericity test	Approximate chi square	203.558
	freedom	120
	Significance	0.000

3.2.2 Extraction of principal components

According to the previous results, we exclude 6 indexes of landscape of rivers and lakes, river seasonality, greening coverage, harmonious degree of architectural color, square landscape, and town morphological saturation coefficient, and then make principal component analysis of 16 style and feature indexes of 22 towns. Table IV indicates that all principal components of the extracted 22 towns have a eigenvalues greater than 1, and its cumulative contribution rate of variance is greater than 85%, so most information of the above 16 indexes can be revealed.

It can be seen from the rotated component matrix in Table V that principal component 1 is streets and lanes and historical features, including: coverage of main street facilities, the number of markers, the number of cultural relics protection sites, the level of cultural relics protection unit, height width ratio of main street, and the square area; Principal component 2 is architectural features, including: architectural style and regional characteristics, continuity of traditional living habits, and distance between river and lake and town center; Principal component 3 is topographic features, including: distance between mountain and town center, mountain height; Principal component 4 is landscape features, including: mountain landscape, identifiable degree of entrance and exit, town aspect ratio; Principal component 5 is climatic features, including: annual average temperature, annual average precipitation.

TABLE IV. Total variance explained

component	Initial eigenvalue			Extract the sum of squares of loads			Sum of squares of rotating loads		
	total	Percentage variance	accumulate %	total	Percentage variance	accumulate %	total	Percentage variance	accumulate %
PC1	5.373	43.583	43.583	5.373	43.583	43.583	4.996	41.227	41.227
PC2	2.897	18.104	61.686	2.897	18.104	61.686	2.437	15.233	56.461
PC3	1.678	10.485	72.171	1.678	10.485	72.171	1.824	11.398	77.859
PC4	1.423	8.895	81.067	1.423	8.895	81.067	1.760	11.000	78.860
PC5	1.223	7.645	88.711	1.223	7.645	88.711	1.576	9.852	88.711

TABLE V. Component load matrix after PCA rotation

index	PC_1	PC_2	PC_3	PC_4	PC_5
Distance between mountain and town center			.867	.296	
mountain height	.481		.683		-.355
Mountain landscape		.326	.114	.735	
Distance between river and lake and town center		-.725	-.197	-.162	.253
Annual average temperature			-.149		.865
Annual average precipitation	-.266	.647	-.224		-.543
Town aspect ratio	-.277	-.158	-.545	.549	-.432

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Height width ratio of Main Street	.760	-.119	.345	-.225	
Coverage of main street facilities	.920	-.233		.116	.155
Identifiable degree of entrance and exit	.364	.129	.149	.674	
Number of markers	.915	-.126			
Square area	.672	-.473		.284	
Architectural style and regional characteristics	.274	.722	-.149	.225	.308
Number of cultural relics protection sites	.875	.170			
Level of cultural relics protection unit	.875	.247	.127		
Continuity of traditional living habits	-.402	.645		.371	

Note: The rotation converges after 16 iterations.

3.3 Cluster Analysis

Based on principal component analysis scores, the towns with similar principal component analysis scores are grouped into one category by cluster analysis. In the pedigree diagram of cluster analysis, as shown in Figure 3, when the inter-class distance is 10, the style of the 22 towns are divided into 8 categories:

The first category includes 6 towns, namely Xiangride Town, Xiariha Town, Chaka Town, Keluke Town, Huaitoutara Town and Tongpu Town, mainly towns with moderate temperature and precipitation, obvious regional characteristics in architectural style, good continuity of traditional living habits and closer distance between river and lake and town center. This result is basically consistent with the principal component analysis scores of the second principal component PC_2 and the fifth principal component PC_5.

The second category includes Delingha City, Xiligou Town, and Chahanwusu Town, mainly towns with high coverage of street facilities, abundant markers, rich historical relics, slightly sparse streets and lanes, moderate open space area. This result is basically consistent with the principal component analysis score of the first principal component PC_1, and is partially consistent with the principal component analysis score of the fourth principal component PC_4 and the fifth principal component PC_5.

The third category includes Xinyuan Town, Muli Town, and Jianghe Town, mainly towns near water, with significant regional characteristics in architectural style and good continuity of traditional living habits in some areas. This result is basically consistent with the principal component analysis score of second principal component PC_2.

The fourth category only has Tanggulashan Town, which is a typical plateau snow mountain town. This result is completely consistent with the principal component analysis scores of the second principal component PC_2 and the fourth principal component PC_4.

The fifth category includes Golmud City and Guolemude Town, mainly towns with faraway mountains and nearby waters, regular town morphology, and rich modern historical relics. This result is basically consistent with principal component analysis score of the third principal component PC_3, and is partially consistent with the principal component analysis scores of the first principal component PC_1 and the fourth principal component PC_4.

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The sixth category includes Huatugou, Xitieshan, and Chaidan Town, mainly towns with faraway low mountains and extremely low precipitation. This result is basically consistent with the principal component analysis scores of the third principal component PC_3 and the fifth principal component PC_5. The seventh category includes Gahai Town and Zongjia Town, mainly towns with faraway mountain and moderate mountain height. This result is consistent with the principal component analysis score of the third principal component PC_3. The eighth category includes Lenghu Town and Koko Town, mainly towns with high average annual temperature, insufficient regional characteristics in architectural style, and poor continuity of traditional life. This result is partially consistent with principal component analysis scores of the second principal component PC_2 and the fifth principal component PC_5.

IV. STATISTICAL RESULTS AND ANALYSIS

On the basis of the 8 categories divided by cluster analysis, the principal components with the highest urban style scores in each category are obtained by comparison, and then the optimal style and feature index of a certain type of towns are obtained by comparison between the optimal principal components. By analyzing the connotation carrier of the style and feature index, it is possible to master the final selected urban style and features of Haixi Prefecture, as shown in Table VI.

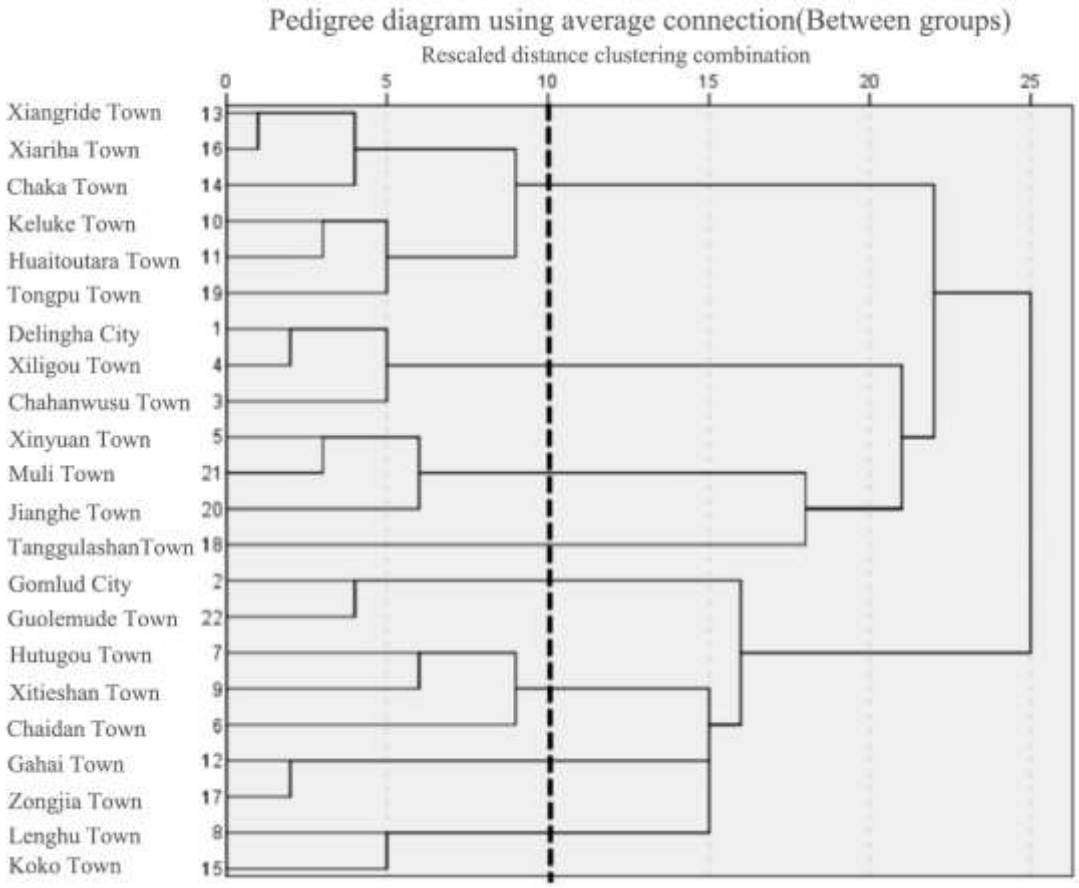

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Figure 3: Pedigree diagram of cluster analysis

TABLE VI. Selected urban style and features of Haixi Prefecture

town	type	Optimal principal component	Optimal style and characteristic index	Features and connotation
Delingha City	2	PC_1	Coverage of main street facilities, Number of markers	Pleasant street space, Dedu Mongolian culture
Gomlud City	5	PC_1, PC_3	Number of cultural relics protection sites, Level of cultural relics protection unit, Street space	**Qaidam** spirit, Pleasant street space, Kunlun snow mountain
Chahanwusu Town	2	PC1	Distance between mountain and town center Number of cultural relics protection sites, Level of cultural relics protection unit	Nomuhong culture
Xiligou Town	2	PC1	Square area	National unity square, Mongolian Commercial Pedestrian Street
Xinyuan Town	3	PC4, PC5	Architectural style and regional characteristics, Distance between river and lake and town center	Tibetan Architecture, Buha River
Chaidan Town	6	PC3, PC4, PC5	Town aspect ratio	Regular belt town, Traffic link
Hutugou Town	6	PC3, PC5	Distance between mountain and town center, Annual average precipitation	Industrial and mining production, Yardang landform
Lenghu Town	8	PC2, PC5	Distance between river and lake and town center, Annual average precipitation	Oil exploitation Yardang landform
Xitieshan Town	6	PC3, PC5	Distance between mountain and town center	Xitieshan mining
Keluke Town	1	PC2, PC5	Architectural style and regional characteristics	Green brick and red tile, History of agricultural reclamation
Huaitoutara Town	1	PC2, PC5	Annual average temperature, Landscape of rivers and lakes	Agricultural landscape and Tourism
Gahai Town	7	PC3	Distance between mountain and town center, Annual average precipitation	Intermountain plain, Agricultural base
Xiangride Town	1	PC2, PC5	Continuity of traditional living habits	Tibetan Buddhism
Chaka Town	1	PC2, PC5	Landscape of rivers and lakes	Chaka Salt Lake landscape
Keke Town	8	PC2, PC5	Architectural style and regional characteristics, Distance between river and lake and town center	Qinghai Tibet Railway Workers Club, **Koko** Salt Lake
Xiariha Town	1	PC2, PC5	Annual average precipitation	Agricultural landscape
Zongjia Town	7	PC3	Distance between mountain and town center, Distance between river and lake and town center	Hydrophilic remote mountain, layout freedom
TanggulashanTown	4	PC4	Distance between river and lake and town center, mountain height, Continuity of traditional living habits	Plateau Snow Mountain, Source of three rivers, Tibetan nomadism
Tongpu Town	1	PC2, PC5	Distance between mountain and town center, Distance between river and lake and town center	Close to mountains and rivers, Belt town
Jianghe Town	3	PC4, PC5	Continuity of traditional living habits	Tibetan customs
Muli Town	3	PC4, PC5	Town aspect ratio	Belt town, Built by the river
Guolemude Town	8	PC2, PC5	Distance between mountain and town center	Looking at Kunlun Snow Mountain

4.1 Natural Style and Features

Among the towns featuring natural style in Haixi Prefecture, Golmud and Guolemude Town feature majestic Kunlun Snow Mountain; Tanggulashan Town features the Qinghai-Tibet Plateau and three river

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source region; Huatugou and Lenghu have vast Yardang landform; Chaka Town features the Chaka Salt Lake known as sky mirror; Huaitoutala, Gahai, and Xiariha feature agricultural scenery of wolfberry planting. Natural style serves as the basic factor influencing urban style. For cities and towns featuring natural style, top priority should be given to protection and expression of natural style in urban planning and development, and man-made damage should be prohibited.

4.2 Artificial Style and Features

Among the towns featuring artificial style in Haixi Prefecture, Golmud features modern urban spaces with comfortable scales; Delingha features pleasant streets and lanes; Xiligou Town features unique Mongolian architectural style; Xiangride Town features Tibetan Buddhist religious buildings; Xinyuan Town features Tibetan-style buildings; the architectural style of Keluke Town is characterized by black bricks and red tiles reflecting the modern red revolutionary spirit; Xitieshan Town features industry and mining; Chaidan Town is characterized by regular square town morphology and transportation hub town; Muli Town is characterized by a belt-type town. Artificial style is an exterior display of urban features. For cities and towns featuring artificial style, attention should be given to the harmony between the existing built environment and new buildings in planning and construction, thereby creating a harmonious and distinctive urban space.

4.3 Humanistic and Cultural Features

Among the towns featuring humanistic and cultural features in Haixi Prefecture, Delingha features Mongolian culture of Dedu; Golmud features the hard-working "Qaidam spirit"; Chahanwusu Town features Nomhon culture; Tanggulashan Town and Jianghe Town feature traditional Tibetan customs. Humanistic and cultural features are the connotation of urban style and features. The humanistic and cultural features of Haixi Prefecture include ancient historical and cultural relics, ethnic folk culture and modern historical and cultural relics. In urban construction and development, attention should be paid to the protection of historical and cultural relics and inheritance of folk culture to display the humanistic sentiments of the city.

4.4 Feature Analysis

According to comprehensive analysis of the selected urban style and features, Golmud City has distinctive natural, artificial and historical features, Delingha City has unique artificial style and cultural features. The reason is that Golmud is the economic center of Haixi Prefecture, and Delingha is its political and cultural center. The economic development level and location factors determine its superior style and features in its comprehensive development. However, Tanggulashan Town and Muli Town can well retain traditional living customs due to its traffic closures and backward economic development. When screening the optimal style and feature indexes, it is found that Xitieshan Town has inferior style and feature indexes compared to other towns of the same type, the index of distance between mountain and town center? is relatively optimal and is thus determined to be a feature. However, the mountain town is based on mine,

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and the entire town serves the purpose of industrial and mining operations, resulting in vague style and features.

V. CONCLUSION AND DISCUSSION

Based on the existing research literature, this paper synthesizes the universal indexes in previous researches, and combines the actual situation and data of Haixi Prefecture to establish a selection index system for urban style and features in Haixi Prefecture. Based on the urban style and feature data of 22 samples, this paper combines descriptive analysis, principal component analysis and cluster analysis to select urban style and features of Haixi Prefecture, with the following conclusions drawn:

(1) Haixi Prefecture embodies the common features of "surrounding by mountains and basins, arid seasonal rivers, and wide distribution of rivers and lakes", "small towns, large scales", and "multiculture and ethnic integration".

(2) Regarding urban style and features of Haixi Prefecture, 9 towns embody the natural style of “Kunlun Snow Mountain, Yardang landform, Chaka Salt Lake, and wolfberry agriculture”; 9 towns embody the artificial style of “industry and mining, unique town morphology, modern and Mongolian-Tibetan fusion architectural style”; 4 towns embody the humanistic and cultural features of “Dedu Mongolian culture, Nomhon culture, Qaidam spirit, traditional Tibetan culture”.

(3) In terms of overall style and features, Golmud and Delingha are two cities with the most distinctive urban style and features in Haixi Prefecture. In general, the towns and cities in Haixi Prefecture embody different characteristics, but mostly natural and artificial, and less humanistic in style.

Although this paper reflects the major style and features of Haixi Prefecture, further improvement is needed. As index value of some index is determined by the expert scoring method, the differences in the subjective cognition of each expert may affect accuracy of the final results to some extent. In further research, it is necessary to explore how to more objectively and accurately access data. In terms of research depth, we mainly make a horizontal comparison of the urban style and features to make selections. However, the vertical comparison of urban style and features is limited to comparison between towns of the same type, lacking overall discussion on the urban style and features of the research objects.

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