A Study on the User Interaction Information System Design of a City Park Planning

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Abstract. The concept of landscape design was born in the 19th century. The design criterion has undergone changes for nearly a hundred years, and the form is constantly changing, but there is always a problem that makes people wonder. What kind of design is a good landscape design? Based on the landscape design criterion summarized in the existing literature, this study uses fuzzy Delphi, analytic hierarchy process (AHP) and technology for order preference by similarity to ideal solution (TOPSIS) to evaluate landscape design criterion. Using above methods, we can deal with the contradictions which arising from the disagreement of the design concept are emphasized in the landscape design, and forming a more uniform design evaluation method. First, use Fuzzy Delphi to evaluate the design concept and determine that the selected design criterion is consistent. And then use the AHP plus TOPSIS to determine the primary and secondary relationships of the landscape design principles by the weight values of the criteria. The research results show that using the above method can quickly and effectively determine the primary and secondary relationship of landscape design criterion, and can achieve better results.

Keywords: Landscape design criterion · Evaluation · Fuzzy Delphi · AHP · TOPSIS

1 Introduction

1.1 The Relationship Between Park and Human

Birkenhead Park, Liverpool, is the first true urban park in the world, the early parks are mostly royal parks or private gardens. When it represented to the city, it improved the urban environment, and the living standards of residents. More importantly, Birkenhead Park provides a reference for people in other regions. We can identify that, park is an urban installation produced in the 19th century. It is a "product of civilization" bred by the unique ideas and systems of West. Nowadays, the most basic function of the park is providing a place where resident visit. With the continuous development of the city, the number of urban parks is also increasing. In the Mainland China, park is responsible for the spiritual civilization education and the popularization of scientific knowledge to the citizens. It is also an important resource for the government to promote social harmony and cultivate urban culture. At some levels, urban cultural experiences and even urban

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cultural symbols tend to be concentrated or hidden in urban parks, so urban parks are the best place to experience local culture. The city is like a hot island, and the park is like a plant on a hot island. The park is rich in plant configuration, and the large water area not only beautifies the city's space, but also regulates the urban environment, improves the city's air quality, and maintains the urban ecological balance. Sometimes when a disaster occurs, the park is responsible for the emergency shelter. As such, the scales of human life in cities will generate different feelings as the surrounding environment changes. Usually, parks can potentially be the center of the region that afford the all kinds of natural elements and provide a place to let people participate and enjoy.

City parks are no longer a luxury for citizens, but an important part for the city growth. In the park, people are both designers and users, and each part has different preferences for the park, which creates different needs. Gehl [1] insisted that the different behavior of people in parks or squares will have more than 10 different directions in the social life of small urban spaces. Usually, people decide their behavior based on the influence of the external environment. In the various behaviors in the park, it is worth exploring on which one is necessary or unnecessary as well as how to define their priorities. According to those priorities, we can examine which aspects of the park/landscape design should be strengthened and others should shorten. But no matter which one all worth us to explore.

There is always a problem in people's minds, what kind of park design is a good park design?

1.2 Literature Review

Nowadays, evaluation studies focus on two areas: qualitative research and quantitative research. Qualitative research accounts for a large proportion of park evaluation research, focusing on the use patterns, functions, ecosystem characteristics and management models of the park. McHarg [2] expanded the scope of traditional "rules" and "design", and raises it to the height of ecological science, making landscape design develop in the direction of multiple comprehensive disciplines [1]. Ahern [3] said that landscape functions can be quantified and measured, they represent our best criteria for such a determination. Francis [4] framed a conceptual framework for understanding the social context of parks versus gardens in cities.

Quantitative research is reflected in the evaluation of ecological benefits, the evaluation of ecological functions and the sustainability of landscapes. Turner [5], suggests that different landscape indexes may reflect processes operating at different scales. Spatial pattern has been shown to influence many processes that are ecologically important. The long-term maintenance of biological diversity may require a management strategy that places regional biogeography and landscape patterns above local concerns. Urban et al. [6] suggested that landscape is a mosaic of patches, the components of pattern, it can help scientists understand spatial patterns.

According to previous literature review, six criteria for park/landscape design can be summarized, which is the basis of this questionnaire. These six criteria cover all aspects of park/landscape design, reflecting the economic and social benefits of the park, the user/visitor experience in the park, the details of the park/landscape design, and the park/landscape level and a series of problems in plant.

1.3 Study Area and Information

Jiageng Park is located in the southeast coast of Jimei District, Xiamen, Fujian Province, it around the sea and connecting the land on the west. The park consists by two parts, the south side is Ji Mei Ao Yuan, a square for the Tan Kah Kee (also known as Chen Jiageng was a Chinese businessman, community leader, communist and philanthropist. He was born in Xiamen, Fujian Province China.) Memorial and the north side is Jiageng Park that was completed in 1994 and remedy in 2016. The park covers an area of 30,000 square meters and the building area is 5,500 square meters. It is a national 4A level scenic spot in China. Entering the garden, you can find that on the top of the pavilions it was Chinese-style and support by western-style pillars, which is the embodiment the Chinese and Western cultural integration. Among them, the most representative ones are “Ao pavilion” and “Mingshi pavilion”, they were built at the 1950s and 1960s, and all has a long history. It can be regard as the extension of the architectural style of Ao Yuan.

In 2012, Xiamen City, Fujian Province revised the Park Management Regulations for Xiamen, is the revision of the 1998 and 2002 version, which consists of five chapters and twenty-nine rules [7]. The regulations stipulate many regulations for the construction, management and use of parks. With the improvement of living standards, people’s aesthetic level and requirements for material culture are also increasing, and the corresponding requirements for providing people’s daily leisure and entertainment parks will increase. The design, construction, management and rational use of the park depend on a complete and scientific evaluation index system to facilitate better improvement and development. Therefore, the establishment of a set of practical evaluation index system suitable for the characteristics of the park is crucial for the construction of park in Xiamen.

2 Method and Result

2.1 Fuzzy Delphi

Delphi can be characterized as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem. In order to accomplish this “communication process”, Delphi method provide “some feedback of individual contributions of information and knowledge; some assessment of the group judgment or’ view; some opportunity for individuals to revise views” [8].

Delphi usually goes through the following four steps. In the first step, the relevant views from different sources (or experts) are collected. In the second step, the respondents verify if they have a broad consensus or a big disagreement about the goals. If there is a big disagreement, this part will be reviewed in the third step to find out the root cause and evaluate it. The fourth step combines the above collected data for sorting and feedback. During the experiment, according to the previous literature review, first we developed a basic survey scope, it including the 6 categories (the questionnaire can be seen below), and then sent to the interviewed group, waiting for their feedback. Six elements of landscape design are economic factors (the following refers to (*a*), aesthetic criterion (*b*), Spatial pattern (*c*), design elements (*d*), construction factors (*e*) and ecological factors (*f*), which serve as the basic criteria for this study (Table 1). Subsequently, a number of experts related to the field were invited to conduct a Delphi questionnaire survey.

The Delphi questionnaire design is shown in Tables 2 and 3 and the analysis steps are detailed as follows.

First, ask each expert to rate A, B, and C aspects for the seven design elements we used. The values range from 0 to 10, and negative > median > positive.

Second**, c**alculate the standard deviation and the average value for each design element separately, first exclude the extreme values outside the "two standard deviations", and then calculate the minimum value C_L of the remaining values, the average value C_M and the maximum value C_U. Then continue to calculate O_L, O_M and O_U according to the above method (see Fig. 1).

Third, according to the Negative Value and Positive Value, create a triangular fuzzy function, as shown in the Tables 4 and 5.

It can be seen from Table 5 that all the final results are greater than 0, indicating that all the experts have a common consensus on the above six criterions. However, it can still be found that the lowest value is the Aesthetic criterion (*b*), is 3.30, far away from the other value. In order to facilitate subsequent research and calculations, this element will be excluded.

Although Delphi has its own advantages, it still has drawbacks. First of all, it is more difficult to select the right expert, and the consultation or collection period is tedious, which is not suitable for the quick judgment and prediction. Secondly, the collection of consensuses is judged by the collective consciousness of experts, usually them has strong personal will. At the same time, Delphi needs to go through multiple rounds of operation, it takes time and effort and easy to make a sloppy response.

2.2 Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP), introduced by Saaty [9], is an effective tool for dealing with complex decision making, and may aid the decision maker to set priorities and make the best decision. By reducing complex decisions to a series of pairwise comparisons, and then synthesizing the results, the AHP helps to capture both subjective and objective aspects of a decision. In addition, the AHP incorporates a useful technique for checking the consistency of the decision maker's evaluations, thus reducing the bias in the decision making process.

Table 1. Evaluation criteria

	Explanation	Degree (0–10)		
		N	M	P
a	Can earn money through tickets? (a1)			
	Generate revenue by tourists? (a2)			
	Can generate cultural benefits? (a3)			
	Whether the park is endemic? (a4)			
	Improve the quality of life of residents? (a5)			

(*continued*)

Table 1. (*continued*)

	Explanation	Degree (0–10)		
		N	M	P
b	Reflect the local aesthetic tendency? (b1)			
	Is the aesthetic element reasonably used? (b2)			
	Is the aesthetic element combined with artistry? (b3)			
c	Difference between the main entrance and the secondary entrance? (c1)			
	Does the park have convenient parking? (c2)			
	Does the park have a complete road system? (c3)			
	Are there enough rest facilities? (c4)			
	Is there a complete lighting system? (c5)			
d	Does design reflect sustainable development? (d1)			
	Does the park have a reasonable layout? (d2)			
	Does the design reflect the artistry? (d3)			
	Does the park have old and famous trees? (d4)			
e	Does the park use local materials? (e1)			
	Does the park reflect the local characteristics? (e2)			
	Are the details of the park reasonable? (e3)			
	Is the facility used in the park safe? (e4)			
f	Is planting suitable for local conditions? (f1)			
	Are plants fit for the architectural style? (f2)			
	Does plant have multiple levels of diversity? (f3)			

The respondents compared the criteria provided in the questionnaire based on their own perceptions (the ratio between the two criteria is shown in the table below). The result is the value for each evaluation criterion, the higher the value represents approximately important and vice versa. Next, for a fixed criterion, assigning scores to each evaluation criterion. A higher score means better performance of the standard represented. Ultimately, the results are integrated and ranked. Because the final ranking and scores are based on the comparison between the offered options and the standard, and the decision maker's knowledge system is embedded in the process, no expert advice is required, making AHP extremely flexible. The calculations are based on a large number of respondents' assessments, which translate many qualitative and quantitative criteria into multi-criteria rankings.

Table 2. 10 experts Delphi questionnaire results 1

	a			b			c		
	N	M	P	N	M	P	N	M	P
Expert 1	7	8	9	3	4	6	5	6	7
Expert 2	5	7	9	2	3	5	3	6	8
Expert 3	4	7	10	3	4	6	6	8	10
Expert 4	7	9	10	2	3	4	5	9	10
Expert 5	5	7	8	3	4	5	7	9	10
Expert 6	4	6	8	2	3	4	7	8	9

(*continued*)

Table 2. (*continued*)

	a			b			c		
	N	M	P	N	M	P	N	M	P
Expert 7	5	7	8	3	4	6	5	6	7
Expert 8	7	8	9	3	5	6	7	9	10
Expert 9	6	7	8	3	4	5	5	6	7
Expert 10	5	6	7	2	3	4	7	9	10
SD	1.18	0.92	0.97	0.52	0.67	0.88	1.34	1.43	1.40
MV	5.50	7.20	8.60	2.60	3.70	5.10	5.70	7.60	8.80
Min	4	6	7	2	3	4	3	6	7
Max	7	9	10	3	5	6	7	9	10

Table 3. 10 experts Delphi questionnaire results 2

	d			e			f		
	N	M	P	N	M	P	N	M	P
Expert 1	4	6	7	6	7	8	5	7	8
Expert 2	5	6	7	5	6	7	2	4	5
Expert 3	3	6	8	5	6	8	5	7	8
Expert 4	4	7	9	7	8	10	6	8	9
Expert 5	6	8	10	7	9	10	4	8	9
Expert 6	5	7	8	6	7	8	6	7	9
Expert 7	7	8	9	4	6	9	3	4	6
Expert 8	7	8	9	4	6	8	2	4	6
Expert 9	6	7	8	4	7	9	3	5	7
Expert 10	7	9	10	5	7	9	3	5	6
SD	1.43	1.03	1.08	1.16	0.99	0.97	1.52	1.66	1.49
MV	5.40	7.20	8.50	5.30	6.90	8.60	3.90	5.90	7.30
Min	3	6	7	4	6	7	2	4	5
Max	7	9	10	7	9	10	6	8	9

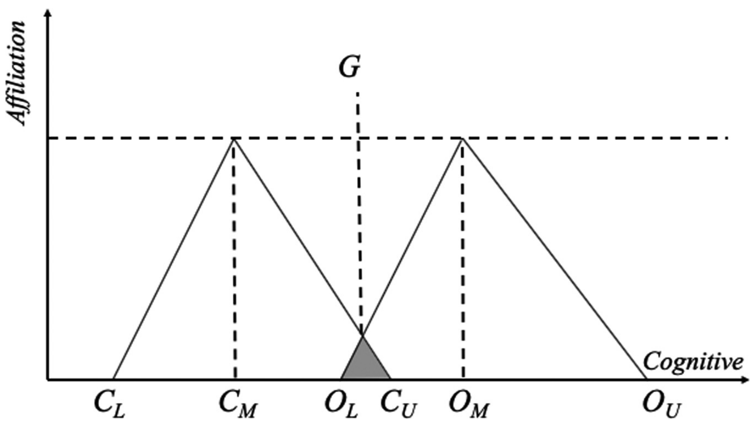

Fig. 1. Triangular fuzzy function

Table 4. Landscape design guidelines statistical analysis results 1

	Negative		Median		Positive		Mean value		
	L	U	L	U	L	U	C	O	S
a	4.00	7.00	6.00	9.00	7.00	10.00	5.50	7.20	8.60
b	2.00	3.00	3.00	5.00	4.00	6.00	2.60	3.70	5.10
c	3.00	7.00	6.00	9.00	7.00	10.00	5.70	7.60	8.80
d	3.00	7.00	6.00	9.00	7.00	10.00	5.40	7.20	8.50
e	4.00	7.00	6.00	9.00	7.00	10.00	5.30	6.90	8.60
f	2.00	6.00	4.00	8.00	5.00	9.00	3.90	5.90	7.30

Table 5. Landscape design guidelines statistical analysis results 2

	O_M-C_M	C_U-O_L	Verification	C_U-C_M	O_M-O_L	Result
a	1.70	1.00	0.70	1.50	1.20	6.10
b	1.10	0.00	1.10	0.40	0.70	3.30
c	1.90	1.00	0.90	1.30	1.60	6.70
d	1.80	1.00	0.80	1.60	1.20	6.40
e	1.60	1.00	0.60	1.70	0.90	5.80
f	2.00	2.00	0.00	2.10	1.90	8.00

First, computing the vector of criteria weight.

In order to calculate the weights of different standards, an n * n real Matrix is created, where n is the quantity to be evaluated. In the matrix, a_{jk} represents the importance of the *j*th criterion relative to the *k*th criterion.

If $a_{jk} > 1$, it means that the *j*th criterion is more important than the *k*th criterion, and vice versa.

If $a_{jk} = 1$, it means that the *j*th criterion is as important as the *k*th criterion.

The entries a_{jk} and a_{kj} satisfy the following constraint: $a_{jk} \cdot a_{kj} = 1$

The same can be proved, $a_{jj} = 1$.

Usually we will use a metric of 1 to 9 to indicate the relative scores between the two standards. If the *j*th criterion is important relative to the *k*th criterion, it is displayed as j: k = 9:1 (7:1, 5:1, 3:1), and vice versa (as shown in Table 6). In this way, the importance between two standards can be easily converted into numbers.

Table 6. Table of relative scores

Value of a_{jk}	Interpretation
1	***j*** and ***k*** are equally importance
3	***j*** is weak importance than ***k***
5	***j*** is essential importance than ***k***
7	***j*** is very strong importance than ***k***
9	***j*** is absolute importance than ***k***

If matrix A is built, we can derive from A the normalized pairwise comparison matrix by making equal to 1, the sum of the entries on each column each entry a_{jk} matrix A is computed as:

The criteria weight w is built by averaging the entries on each row of A:

Second, computing the matrix of option scores. The matrix of option scores is a n * m real matrix S. Each entry s_{ij} of S represents the score of the ith option with respect to the jth criterion. In order to derive such scores, a pairwise comparison matrix $B^{(j)}$ is first built for each of the m criteria, j = 1, … , m. The matrix $B^{(j)}$ is a n * n real matrix, where n is the number of options evaluated. Each entry $B^{(j)}$ of the matrix $B^{(j)}$ represents the evaluation of ith the ith option compared to the hth option with respect to the jth criterion.

If $b_{ih}^{(j)} > 1$, then the ith option is better than the hth option, while if $b_{ih}^{(j)} < 1$, then the ith option is worse than the hth option.

If two options are evaluated as equivalent with respect to the jth criterion, then the entry $b_{ih}^{(j)} = 1$.

The entries $b_{ih}^{(j)}$ and $b_{hi}^{(j)}$ are satisfy the following constraint:

Finally, ranking the options. However, in the process, we should try to avoid inconsistencies between standards and evaluation. The consistency of the calculation matrix is usually used to test the standard of mutual comparison, and will be described only for the matrix A. The Consistency Index (CI) is obtained by first computing the scalar x as the average of the elements of the vector whose jth element is the ratio of the jth element of the vector $A \cdot w$ to the corresponding element of the vector w. Between decision maker should always obtain CI = 0. Inconsistencies within the margin of error are tolerable, which ensures that the AHP is expected to be reliable. RI is the Random Index, the consistency index when the entries of A are completely random. The values of RI are illustrated in Table 7.

Table 7. Values of the Random Index (RI) for inconsistencies

m	2	3	4	5	6	7	8	9	10
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

In the course of the survey, 20 questionnaires were distributed and recovered.

Firstly, the consistency of the five-landscape design criterion was tested. 14 valid questionnaires were selected, and the Consistency Ratio was 0.0349 < 0.1, within the confidence interval, which proves that 14 questionnaires have high consistency and can be adopted, used as a basis for research. The AHP assignment and weight of each principle are illustrated in Tables 8 and 9.

Table 8. Values of the AHP assignment of five design principle

	a	c	d	e	f
a	1.000	0.322	1.095	0.697	2.356
d	3.103	1.000	2.802	2.020	5.824
c	0.913	0.357	1.000	0.704	2.552
e	1.434	0.495	1.419	1.000	2.688
f	0.424	0.172	0.392	0.372	1.000
Sum	6.874	2.346	6.708	4.794	14.421

Table 9. Weight of the five-design principle

	a	c	d	e	f	Weight
a	0.145	0.137	0.163	0.145	0.163	0.151
d	0.451	0.426	0.418	0.421	0.404	0.424
c	0.133	0.152	0.149	0.147	0.177	0.152
e	0.209	0.211	0.212	0.209	0.186	0.205
f	0.062	0.073	0.058	0.078	0.069	0.068

It can be found that the park's Spatial pattern (*c*) impressed the respondents, and the park did not impress too much on the ecological factors (*f*).

Then, continue to calculate the weights occupied by each factor, and multiply the weight of each factor by the weight of the associated section to obtain the weight of each factor in the overall evaluation. The first one is the evaluation of the Economic factor (a), it's value and factor weight and overall weight are shown in the Table 10.

The second is Usage principle, shown in the Table 11.

The third is design elements, shown in the Table 12.

The fourth is construction factors, shown in the Table 13.

The last one is the ecological factors, its detail shown in the Table 14. All details are displayed in subsequent content.

Table 10. Values of the economic factor and weight

	a1	a2	a3	a4	a5	Factor weight	Overall weight
a1	1.000	0.299	1.190	0.249	0.334	0.082	0.0125
a2	3.343	1.000	3.005	1.088	1.586	0.297	0.0037
a3	0.841	0.333	1.000	0.247	0.233	0.075	0.0003
a4	4.012	0.919	4.046	1.000	1.482	0.309	0.0001
a5	2.997	0.630	4.298	0.675	1.000	0.237	0.0000
Sum	12.193	3.182	13.539	3.259	4.634		

Table 11. Values of the usage principle and weight

	c1	c2	c3	c4	c5	Factor weight	Overall weight
c1	1.000	0.364	0.328	0.303	1.083	0.092	0.0389
c2	2.749	1.000	1.069	1.053	2.051	0.256	0.1086
c3	3.045	0.935	1.000	0.823	3.429	0.267	0.1132
c4	3.298	0.950	1.214	1.000	3.145	0.288	0.1222
c5	1.050	0.488	0.292	0.318	1.000	0.097	0.0410
Sum	11.142	3.737	3.904	3.497	10.708		

Table 12. Values of the design elements and weight

	d1	d2	d3	d4	Factor weight	Overall weight
d1	1.000	0.480	0.634	3.337	0.830	0.1262
d2	2.083	1.000	1.837	5.088	1.734	0.2636
d3	1.577	0.544	1.000	4.435	1.154	0.1753
d4	0.300	0.197	0.225	1.000	0.282	0.0429
Sum	4.960	2.221	3.697	13.860		

Table 13. Values of the construction factors and weight

	e1	e2	e3	e4	Factor weight	Overall weight
e1	1.000	1.594	1.150	0.225	0.150	0.0307
e2	0.627	1.000	0.604	0.166	0.094	0.0192
e3	0.897	1.655	0.855	0.214	0.136	0.0278
e4	4.440	5.844	4.679	1.000	0.620	0.1272
Sum	6.965	10.093	7.289	1.605		

Table 14. Values of the construction factors and weight

	e1	e2	e3	Factor weight	Overall weight
e1	1.000	0.729	1.010	0.293	0.0199
e2	1.371	1.000	1.927	0.447	0.0304
e3	0.990	0.519	1.000	0.260	0.0177
Sum	3.361	2.248	3.937		

2.3 Technique for Order of Preference by Similarity to Ideal Solution

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is a multi-criteria decision analysis method [10]. According to the closeness of the evaluation and the idealized target, then ranking. Find out the optimal solution and the negative solution in the scheme through the normalized matrix. Calculate the distance from the evaluation to the optimal solution and the negative solution, respectively. The relative proximity of each evaluation object to the optimal solution is obtained as a basis for evaluating the merits and demerits.

When encountering multi-objective optimization problems, there are usually m targets $D_1, D_2, \ldots, D_m$, and each target has n indicators $X_1, X_2, \ldots, X_n$. First, experts are invited to score the indicators, and then the score results are expressed in the form of mathematical matrix, and the following characteristic matrix is established:

$$D = \begin{bmatrix} x_{11} & \cdots & x_{1j} & \cdots & x_{1jn} \\ \vdots & & \vdots & & \vdots \\ x_{i1} & \cdots & x_{ij} & \cdots & x_{in} \\ \vdots & & \vdots & & \vdots \\ x_{m1} & \cdots & x_{mj} & \cdots & x_{mn} \end{bmatrix} = \begin{bmatrix} D_1(x_1) \\ \vdots \\ D_i(x_j) \\ \vdots \\ D_m(x_n) \end{bmatrix} = \left[X_1(x_1)\cdots X_i(x_j)\cdots X_n(x_m)\right] \tag{1}$$

Normalize the feature matrix to obtain the normalized vector r_{ij} and build the matrix:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} (i = 1, 2, \ldots, m, j = 1, 2, \ldots, n) \tag{2}$$

Then normalize the value v_{ij} by calculating the weight and build the matrix:

$$v_{ij} = w_j r_{ij}, i = 1, 2, \ldots, m, j = 1, 2, \ldots, n \tag{3}$$

Here, w_j refers to the weight of the *j*th indicator. Determine optimal solution (A^+) and negative solution (A^-) according to the weight normalization value v_{ij}.

$$A^+ = \left(max_i v_{ij} \middle| j \in J_1\right), \left(min_i v_{ij} \middle| j \in J_2\right), |i = 1, 2, \ldots, m = v_1^+, v_2^+, \ldots, v_j^+, \ldots, v_n^+ \tag{4}$$

$$A^- = \left(min_i v_{ij} \middle| j \in J_1\right), \left(max_i v_{ij} \middle| j \in J_2\right), |i = 1, 2, \ldots, m = v_1^+, v_2^+, \ldots, v_j^+, \ldots, v_n^+ \tag{5}$$

J_1 is a set of profitability indicators, indicating the optimal value on the *i*th indicator; J_2 is the loss-disaggregation indicator set, indicating the worst value on the *i*th indicator. The greater the profitability indicator, the better the evaluation result; the smaller the loss index, the better the evaluation result, and vice versa.

Calculate the distance from target to the positive idea solution and the negative ideal solution. The distance from the target to the positive idea solution A^+ is S^+, and the distance from the negative ideal solution A^- is S^-:

$$S^+ = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V_j^+\right)^2} \tag{6}$$

$$S^- = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - V_j^-\right)^2} \tag{7}$$

v_j^* and v_j^- are the distances from the *j*th target to the optimal target and the worst target, respectively, and v_{ij} is the weight normalized value of the *j*th evaluation index of the *i*th target. S^* is the proximity of each evaluation target to the optimal target. The smaller the S^* value, the closer the evaluation is the ideal target, and the better the solution. When $C_i^* = 0$, $A_i = A^-$ indicates that the target is the worst target; when $C_i^* = 1$, $A_i = A^*$, indicating that the target is the optimal target.

In actual multi-objective decision making, the optimal target and the worst target are less likely to exist.

$$C_i^* = \frac{S_i^-}{(S_i^* + S_i^-)}, \quad i = 1, 2, \ldots, m \tag{8}$$

Finally, each target is arranged from small to large according to the value of C^*. The result more closely to C^* value, means the better target is, and the largest C^* value is the optimal target. For this evaluation, the largest weight is the optimal solution, and the smallest weight is the negative ideal solution. Because the content contained in the questionnaire is inconsistent, the vacant part is replaced by 0. All weights are listed in Table 15, and the maximum and minimum values in the matrix are found to be the optimal solution and the negative ideal solution. The optimal solution will be labeled as red and negative as grey.

Table 15. Weighted matrix of 5 criteria

	1	2	3	4	5
a	0.0825	0.2973	0.0747	0.3087	0.2369
c	0.0918	0.2562	0.2671	0.2882	0.0967
d	0.1499	0.0938	0.1358	0.6204	0.0000
e	0.1499	0.0938	0.1358	0.6204	0.0000
f	0.2929	0.4474	0.2598	0.0000	0.0000
Max	0.2929	0.4474	0.2671	0.6204	0.2369
Min	0.0825	0.0938	0.0747	0.2882	0.0967

The optimal solution is:

$$A_i^* = (0.2929, 0.4474, 0.2671, 0.6204, 0.2369)$$

The negative solution is:

$$A_i^- = (0.0825, 0.0938, 0.0747, 0.2882, 0.0967)$$

Calculate the distance between 5 principles and optimal solution and negative solution, get D_i^+ and D_i^-, and proximity value (C_i) and ranking as illustrated in Table 16. Based on the proximity value, the order of the Ao yuan landscape design criterion is: Construction factors, Economic factors, Spatial pattern, Design elements, Ecological factors. If based on the weight of the design principle, the order is: Spatial pattern, Construction factors, Economic factors, Design elements, Ecological factors. There has been a change in ordering.

Table 16. D_i^+, D_i^-, and C_i value

	D_i^+	D_i^-	C_i	Ranking	Ranking in weighted
a	0.4579	0.3878	0.4586	2	3
c	0.4555	0.3560	0.4387	3	1
d	0.6050	0.4233	0.4117	4	4
e	0.4741	0.5861	0.5528	1	2
f	0.6647	0.4550	0.4064	5	5

3 Conclusion

This study uses Fuzzy Delphi, AHP, TOPSIS, etc., and selects the landscape design of Jimei Ao yuan as the research object. Through research, it can be found that Fuzzy Delphi can quickly obtain the consensus of experts when confirming the relevant criteria. The evaluation of landscape design by AHP collection TOPSIS can achieve more reasonable results than the traditional public perception of landscape design. The traditional methods of landscape design evaluation have different standards and diverse concepts, and can only be used to give ambiguous evaluations of impressions.

When using traditional evaluation methods, Spatial pattern and Construction factors usually at the center of the core. Using AHP and TOPSIS, we can find that in the evaluation of Ao yuan landscape design, Construction factor and Economic factor played an important role.

According to this process, in the future, landscape architects or park managers and maintainers can quickly meet the different needs of people, and can accurately discover the deficiencies in the park and improve them. The park development and construction will enable the park to continue to present a good state of environmental quality, enabling Jimei Ao yuan to achieve high-speed, healthy and stable sustainable development.

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