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Recreation and Tourism Service Systems Featuring High Riverbanks in Taiwan

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Abstract: Taiwan's cities exhibit high levels of urbanization, which has resulted in limited recreation space in urban areas. In response, government policies have been enacted to promote the large-scale greening of rivers in urban areas and the establishment of aquatic recreation areas that do not interfere with water flow areas, pavilions for recreation purposes, indoor stadiums, and biking lanes alongside riverbanks to provide citizens with recreation space. An expert team was convened to investigate 50 riverside recreation sites, and the Comfortable Water Environment Rest Assessment Form was devised. The investigation results revealed three factors that contribute to the value of riverside recreation sites; the three factors had a total explanatory power of 70.17%. The factors, namely exercising and leisure, overall design plan and entrance image, and environmental maintenance and service, had an explanatory power of 25.52%, 23.32%, and 21.32%, respectively. Finally, this study provides guidance for constructing service systems for riverside recreation sites by referencing practical cases. This study suggests that future designs focus on the characteristics of visitors as the main consideration when investing resources in recreation sites. In addition, more exercise and recreation equipment and facilities should be provided at recreation sites located within highly populated areas. For recreation sites that feature beautiful scenery, greater degrees of overall design planning and entrance image qualities can be integrated into the recreation sites, and environmental teaching materials can be incorporated into the environment. Furthermore, this study suggests that residents who live near recreation sites form and operate volunteer groups to contribute to environmental maintenance and the relevant services; this would greatly enhance the overall experience of comfort of visitors to the recreation sites. Finally, this study provides guidance for low-intensity construction in high riverbank areas.

Keywords: recreation and tourism; high riverbanks; comfortable water environment rest assessment form

1. Introduction

The objective of this study was to improve the recreation and tourism services of high riverbanks. The constant expansion of cities has contributed to the diminishing green space available to the public. Hence, high riverbanks have become popular and attractive sites for recreation. The functions of high riverbanks in urban areas include preventing floods, storing water, removing pollutants, protecting and enhancing aquatic ecology and ecosystems, stabilizing river flow, extending the lag time for floods, protecting civil engineering structures on both sides of the bank, lowering flood potential on both banks, being transformed into constructed wetlands, increasing urban green space, promoting biodiversity, and enhancing environmental impact tolerance. Human expectations for the use of river spaces have resulted in a variety of high riverbank functions. Studies have ascertained the benefits of high riverbank functions [1–13]. In Taiwan, the dry period for seasonal rivers can be as long as seven or eight months. In Taiwan, river governance measures depend on whether water levels are high or low. High water levels only occur during floods and are rare, whereas a low water level represents the basic condition of the river, which is typically conducive to ecosystem functions. To protect the flood prevention function of rivers, relevant regulations can be established to regulate the construction intensity in river regions. However, construction methods that meet the demands of protecting natural ecosystems and environments and developing a river space for water recreation experiences as well as integrate historical cultural monuments and the natural landscape do not exist. Therefore, we can only establish conceptual construction methods [14,15].

However, given the unique characteristics of high riverbanks, limitations abound regarding the development of such sites, including restrictions on the depth and width of the development and the use of low-rise buildings and dwarf plants. The use of a high riverbank should be designed, planned, and maintained. First, high riverbanks in urban areas are connected via various transportation channels and located near convenient transportation systems, which enables them to draw crowds. These riverbanks allow for local resident visitors to take walks, provide children with play areas, render space for parks and exercise equipment, and provide citizens with space to exercise and engage in recreational activities (e.g., biking), and thus they are suitable for citizens of all ages to visit. By contrast, tourist visitors favor unique exercise facilities and scenic designs, such as baseball stadiums, bike lanes, suspension bridge landscapes, riverbank scenic landscapes, and environmental education installations. Therefore, designs of high riverbank areas in urban areas should aim to offer the aforementioned accommodations. Regarding the cleaning and maintenance of high riverbanks in urban areas, the public sector should take responsibility for maintenance tasks, including repairing hardware and maintaining mechanical operations (e.g., water gate maintenance). Since high riverbanks are located near communities, both cleaning personnel from the public sector and local residents are responsible for environmental protection tasks. In addition, a large proportion of maintenance is conducted by local residents [16,17]. In 2000, ecosystem engineering was introduced for the governance of rivers [15,18]. Discussions have been continuing regarding how to increase biological habitats, considerably reduce maintenance costs and workload, and enhance the application of ecological construction methods without affecting the flood prevention strength of the riverbanks. Furthermore, climate change and increased episodes of extreme rainfall are disadvantageous to the development of riverbank spaces and increase the difficulty of the governance of urban drainage and rivers. These issues have become popular research topics in recent years [19,20].

To promote exercising and recreational activities, Taipei City has endeavored to improve the water quality of the Tamsui River (goal: dissolved oxygen level > 2; the river does not smell) and promoted the construction of facilities on both riverbanks, including riverside bike lanes, exercise and recreational facilities, playgrounds suitable for all ages, and riverbank scenic landscapes [15]. Through this, the riverbank space has been transformed into a multipurpose leisure and recreation space featuring recreational entertainment, ecological conservation, and age-inclusive properties. Visitors may take rapid public transit to the riverbank, rent bicycles from a bike-sharing system, and then ride to the riverbank ecosystem observation section. On such a journey, visitors may experience a natural sense of comfort, making a visit to the riverbank attractive. From river governance to creating a connection with the river, Taipei City has converted the high riverbank into an ecological classroom and playground, thereby transforming the high riverbank of Tamsui River into a hotspot for leisure outings and encouraging the economic development of relevant industries.

No effective quantitative method for solving the aforementioned developmental limitations exists in Taiwan or any other country, although centuries worldwide have abundant experience with river restoration, have combined river development with recreation and tourism, and have even integrated river development with urban functions [21–24]. On the basis of Taiwan's rich experience in developing high riverbanks, this study proposes an analytical scale for a comprehensive quantitative analysis of such development and engages in a qualitative discussion before providing constructive methods and procedures for high riverbank development.

2. Materials and Methods

2.1. Research Material

This study selected 29 rivers in Taiwan (Tamsui River, Nankang River, Laojie River, Touqian River, Zhonggang River, Houlong River, Da'an River, Dajia River, Fazi River, Zhuoshui River, Beigang River, Puzih River, Bazhang River, Jishui River, Erren River, Agongdian River, Houjin River, Ai River, Gaoping River, Linbian River, Gangkou River, Sihchong River, Beinan River, Liwu River, Hualien River, Nan'ao River, Xincheng River, Lanyang River, and Shuanghsi River) and 50 high riverbank recreational areas that include 9 constructed wetlands, 29 parks, 4 bike lanes, 4 education centers, 3 scenic sites, and 1 hot spring for investigation. Figure 1 presents the investigation sites, and Table 1 lists the basic information about the rivers within the investigation sites.

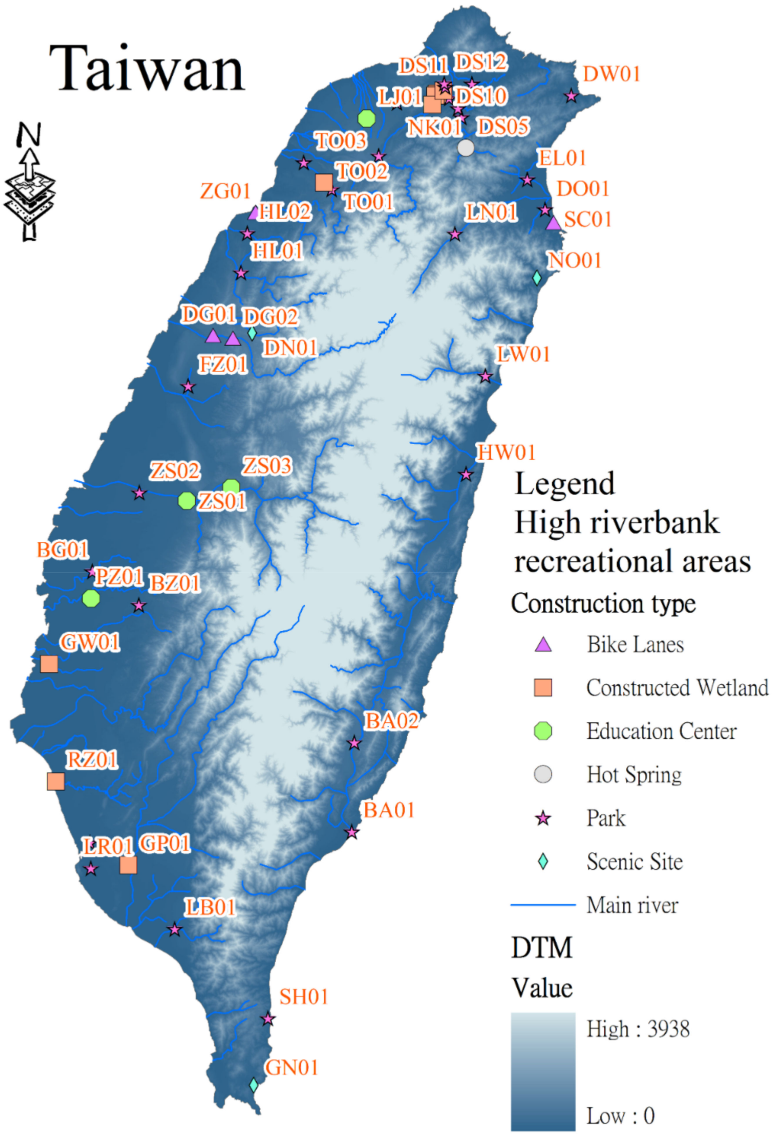

Figure 1. Distribution of investigation sites.

Table 1. Information about the rivers within the investigation sites.

No.	River Names	Main River Length km (Catchment Area km^2)	Average Annual Rainfall in the Basin (mm)	Water Resource Utilization	Points of the River Basins
1	Lanyang River	73 (978)	3256	Public water supply and Agricultural water	Downstream
2	Tamsui River	158.7 (2726)	2966	Public water supply and District drainage	Midstream
3	Touqian River	60.03 (565.94)	2239	Public water supply and Agricultural water	Downstream
4	Zhonggang River	54.14 (445.58)	2391	Agricultural water	Downstream
5	Houlong River	58.3 (537)	1988	Public water supply and Agricultural water	Downstream
6	Da'an River	95.76 (758.47)	2354	Public water supply and Industrial water	Midstream
7	Dajia River	124.2 (1235.73)	2372	Public water supply and Industrial water	Midstream
8	Hualien River	57.28 (1507.09)	2550	Public water supply and Agricultural water	Downstream
9	Erren River	61.2 (339.2)	2730	Public water supply and Agricultural water	Downstream
10	Beinan River	84.35 (1603.21)	3062	Public water supply and Agricultural water	Downstream
11	Bazhang River	80.86 (474.74)	2432	Public water supply and Agricultural water	Midstream
12	Puzih River	75.87 (426.60)	2406	Public water supply and Agricultural water	Midstream
13	Jishui River	65.00 (379.00)	2604	Public water supply and Agricultural water	Downstream
14	Nankang River	44.01 (214.6)	2219	Agricultural water and District drainage	Midstream
15	Laojie River	36.70 (81.59)	2232	Agricultural water and District drainage	Midstream
16	Fazi River	21.25 (132.6)	2392	Agricultural water and District drainage	Midstream
17	Zhuoshui River	186.6 (3156.9)	2453	Agricultural water and Industrial water	Midstream
18	Beigang River	82.0 (645.21)	2401	Public water supply and Agricultural water	Midstream
19	Agongdian River	38.0 (137.07)	3018	Public water supply and Agricultural water	Downstream
20	Houjin River	13.0 (73.45)	3014	Public water supply and Agricultural water	Downstream
21	Ai River	12.0 (56.0)	3006	District drainage	Downstream
22	Gaoping River	171.0 (3256.85)	3046	Public water supply and Agricultural water	Midstream
23	Linbian River	41.30 (336.30)	3062	Agricultural water and District drainage	Downstream
24	Gangkou River	32.0 (101.69)	3054	Agricultural water and District drainage	Downstream
25	Sihchong River	31.91 (124.88)	3085	Agricultural water and District drainage	Downstream
26	Liwu River	55 (616)	3152	Agricultural water and District drainage	Downstream
27	Xincheng River	18.13 (50.46)	3204	Agricultural water	Downstream
28	Nan'ao River	48.40 (311.73)	3212	Public water supply and Agricultural water	Downstream
29	Shuanghsi River	26.81 (132.50)	3224	Public water supply and Agricultural water	Downstream

2.2. Onsite Investigation

The researchers conducted field research and visited the selected investigation sites to experience and observe the leisure areas. The main investigation team comprised three researchers, two families with parents and children (the youngest family member being 2 years old), two cycling enthusiasts, and two older adults. The research team comprised Master's students and project assistants familiar with the basic knowledge of the water environment. The families were constituted mostly by environmental protection volunteers who possessed environmental protection knowledge and experience of traveling with children. The cyclists referred to bicycle enthusiasts with more than 10 years of experience in cycling or cycling as a leader. The senior team comprised retired couples with a passion in environmental protection and were hired to assist in the survey. During the investigation, the investigation team walked and rode bicycles while wearing GPS-enabled devices to record their traveled routes, elevation gain/loss, and slope angle. In addition, the investigation team photographed the vegetation conditions of each site. Investigation of each site lasted at least 2 h. The survey was conducted at each survey site during daytime which was divided into three time periods: from 11 AM to 1 PM (period A), from 2 PM to 4 PM (period B), and from 5 PM to 7 PM (period C) (only added period C on weekdays), on each weekend. The aim of this survey design was to maximize the number of survey participants (please see Table 2). During the investigations, the team observed the number of hourly visitors, the ecological system around the traveled routes and bicycle lanes, the recreational scenic sites, the resting areas, and the visitor service centers. In addition, the team personally experienced and observed the weather of the investigation sites to determine whether it was frequently sunny or rainy at each site; each investigation ended if it rained. Prior to visiting, the researchers collected information from announcements by government tourism agencies and relevant websites established by tourism enthusiasts to understand the bike paths and maps of the investigation sites as well as to reference the recreational experiences of other netizens. The investigation period was between July and October 2019, which was during the summer vacation for students in Taiwan, prior to the outbreak of the COVID-19 pandemic and during a time when life was normal. The number of tourists surveyed reflected the popularity of the recreation and tourism sites. For this study, the research team made 734 onsite investigation visits. However, the number of people surveyed in the same time period at different recreation sites may not have the same benchmark. Additionally, this study was limited in that it did not distinguish between tourists (out-of-town) and local residents.

Table 2. Survey time and recording distribution detected from fact sheets.

Working Day	Investigation Area Code	Time Period	Person Times	Working Day	Investigation Area Code	Time Period	Person Times
Day 1	DS-06	A	16	Day 15	ZS-01	A	52
	DS-07	B	16		ZS-02	B	52
	DS-08	C	16		ZS-03	C	51
Day 2	DS-10	A	11	Day 16	BG-01	A	12
	DS-11	B	11		PZ-01	B	12
	DS-12	C	11		BZ-01	C	12
Day 3	DS-01	B	8	Day 17	GW-01	D	8
	DS-02	C	8	Day 18	RZ-01	D	9
Day 4	DS-03	D	6	Day 19	YG-01	A	12
Day 5	DS-04	B	10		HO-01	B	12
Day 6	DS-05	B	11		LR-01	C	12
Day 7	DS-09	B	11	Day 20	GP-01	B	47
Day 8	DS-13	B	8	Day 21	LB-01	B	7
	LJ-01	C	8	Day 22	GN-01	B	6
Day 9	NK-01	D	9		SH-01	C	6
Day 10	TO-01	A	10	Day 23	BA-01	B	7
	TO-02	B	10		BA-02	C	7
	TO-03	C	10	Day 24	HW-01	B	45

Table 2. *Cont.*

Working Day	Investigation Area Code	Time Period	Person Times	Working Day	Investigation Area Code	Time Period	Person Times
Day 11	ZG-01	B	8	Day 25	LW-01	B	8
	HL-02	C	8	Day 26	NO-01	B	9
Day 12	HL-01	D	5	Day 27	SC-01	B	21
Day 13	DN-01	A	9		DO-01	C	21
	DG-01	B	9	Day 28	LN-01	B	25
	DG-02	C	9		EL-01	C	25
Day 14	FZ-01	B	8	Day 29	DW-01	B	10

Note: The Zhuoshui River Forum activities were held at ZS-01, ZS-02, and ZS-03 on working day 15. Constructed wetland visits were held at GP-01 on working day 20. Outdoor learning activities were held at HW01 on working day 24. Family day activities were held on working days 27 and 28. These survey periods were determined according to the time periods when most tourists visit the recreation sites: all day on Saturdays, all day on Sundays, and 5–7 PM on weekdays. A: 11 AM–1 PM on weekends. B: 2–4 PM on weekends. C: 5–7 PM on weekends. D: 5–7 PM on weekdays.

2.3. Establishment of the Comfortable Water Environment Rest Assessment Form

The study team held five workshops on becoming familiar with water environments and cherishing river and water resources. The workshops were chaired by five experts, with 40 enthusiasts invited to attend and engage in discussions with the experts. Subsequently, the researchers referenced suggestions from the relevant literature and formulated the Comfortable Water Environment Rest Assessment Form (CWERAF; Table 3.) [25–31]. By referencing each variable in the CWERAF, the researchers inspected the advantages and disadvantages of each recreational site. The researchers explained the principles of each index and the scoring method to each investigator to ensure that the indices were scored under the same principles. After completing an investigation, the investigators convened a group meeting to discuss and confirm the scoring of each index. When the investigators' opinions diverged, the investigators conducted a discussion using the Delphi method to ensure scoring consistency [32].

Table 3. Comfortable Water Environment Rest Assessment Form.

Index	Variable	Description
CW1	Aquatic zones	(5) Has aquatic zones and relevant tools; (3) has plans to develop aquatic zones; (1) does not have aquatic zones
CW2	Bike paths	(5) Has exclusive bike paths or shared bike/pedestrian paths; (3) has bike paths and bike lanes on roadways; (1) does not have bike paths
CW3	Service center	(5) Has a service center with clusters of shops or vendors; (3) has a service center; (1) does not have a service center
CW4	Entrance image	(5) Has an entrance image and the image is unique; (3) has an entrance image and the image is mediocre; (1) does not have an entrance image
CW5	Information boards	(5) Has information boards with educational information; (3) has information boards with general information; (1) does not have information boards
CW6	Cleaning and maintenance conditions	(5) Receives cleaning and maintenance and has high cleanliness; (3) receives cleaning and maintenance regularly and has standard cleanliness; (1) has low cleanliness
CW7	Parking lots	(4) Has multiple parking lots; (3) has a parking lot; (2) does not have a parking lot, but it is easy to park nearby; (1) does not have a parking lot and parking is difficult nearby
CW8	Exercise facilities	(5) Has exercise facilities and all of them are usable; (3) has exercise facilities, but not all of them all usable; (1) does not have exercise facilities
CW9	Overall design plan	(5) Has a distinctive design plan; (3) has a design plan, but the design is not distinctive; (1) does not have a design plan
CW10	Mass transportation accessibility	(5) Is accessible via two or more modes of mass transportation; (3) is accessible via one mode of mass transportation; (1) inaccessible through mass transportation
CW11	Number of hourly visitors	Recorded by the 10s of persons. If the number of hourly visitors exceeds 100, record as ">100"

During the meetings, all participants were asked to provide written comments and rate each item anonymously. Everyone was then engaged in a group discussion on parameters with excessively large variances. Subsequently, a second round of rating was conducted, followed by a group discussion. Gathering feedback from experts in multiple rounds is a critical process of the Delphi method. After the fourth round, the host of the discussion session, which was assumed by Researchers 1, 2, and 3 in turn (the host must be a surveyor of the particular recreation site of the discussion), finalized the ratings of parameters that the surveyors had reached an agreement on and initiated discussion on those rated inconsistently by the participants. The process was repeated until a consensus was reached for the ratings of all parameters. In this study, the ratings of all recreation sites were completed in the fourth round, which was also a parameter of this study—quality control (QC).

The indices, which function as quantified measurement instruments, are divided into functional, service, and overall design dimensions, of which the specific items are aquatic zones, bike paths, exercise equipment, and environmental cleanliness and maintenance conditions; service center, entrance image, information boards, parking lots, and mass transportation accessibility; and overall design planning and number of hourly visitors, respectively.

After investigation, the researchers labeled each answer option with sequential scores and used the Ridit analysis to compute the scores for each site, which were used for multivariate analysis [33].

2.4. Multivariate Analysis

Multivariate statistical processing, also known as multivariate analysis, requires considerable amounts of computation. Since the popularization of high-speed calculators, development in the field of multivariate analysis has exhibited exponential growth. Multivariate analysis encompasses various subfields, including multiple regression analysis, discriminant analysis, analysis of covariance, multidimensional scaling analysis, and cluster analysis [34].

Explanatory factor analysis primarily evaluates the number of underlying variables (i.e., factors) within a set of observed variables. The analysis process is detailed as follows: First, we hypothesize that a set of observed variables are affected by a common factor and calculate their correlation with said factor. Subsequently, we exclude the correlation value and search for the next factor that can explain the remaining covariance relationship and repeat the process until all variation is explained. At this stage, the number of extracted factors equals the total number of items for the observed variables. However, because most factors do not have high explanatory power, various methods are used to determine the number of factors, such as determining whether the eigenvalue of a factor is >1, which means the explanatory power of the variable is strong [34,35].

In cluster analysis, cluster classification is conducted on clusters of samples comprising multiple variables, and samples with similar properties and characteristics are classified into the same cluster. The analysis results are presented in a tree-shaped structure, which is highly similar to the shape of a phylogenetic tree. Samples with higher correlation are connected first to form small clusters; subsequently, small clusters are connected with other small clusters or unconnected samples in sequence according to their correlation. The process is repeated until a single cluster is formed. When the phylogenetic tree is complete, the relationship between the samples becomes apparent. The number of clusters classified in this process is determined by the set likelihood value [36].

Logistic regression resembles the linear regression model. Regression analysis describes the relationship between a dependent variable and one or many predictor variables. In regression analysis, the dependent variables and the independent variables are generally continuous variables. By comparison, logistic regression analysis is used when the dependent variables are discrete variables [37]. In particular, logistic regression analysis is generally used for dichotomous classification, such as "agree or disagree" and "succeed or fail." The purpose of logistic regression is to establish simplified analysis results with the highest fit. When applied in practical and reasonable models, the established model can be used to predict the relationship between a dependent variable and a set of predictor variables. Logistic regression analysis differs from other multivariable analysis methods because it does not require the assumption of a distribution type. In logistic distribution, the relationship between a dependent variable and one or more independent variables aligns with a logistic function. This indicates that in logistic regression, the assumption of normal distribution is unnecessary. However, if the predictor variables have a normal distribution, the logistic regression results are more reliable. In logistic regression analysis, independent variables can be categorical variables or continuous variables. We employed logistic regression analysis to analyze the correlation between the number of visitors and the other variables of the recreational environment [38].

3. Results

3.1. CWERAF Results and the Number of Visitors

Table 4 displays the total index scores and number of hourly visitors of the 50 investigation sites. The CWERAF comprises 11 indices, with the highest total score being 10 points. For sites with over 100 and approximately 20 hourly visitors, the total index scores ranged from 7.6 to 8.8 and 2.8 to 6.4, respectively. Higher total index scores indicate that the software and hardware of the service system are more attractive, functional, or otherwise preferable, with the opposite being true for sites with lower total index scores. The differences between total index scores are reflected in the number of hourly visitors.

Table 4. Distribution of the Comfortable Water Environment Rest Assessment Form (CWERAF) scores and number of tourists in 50 survey areas.

Code	Sum_Ridit	Visits per Hour	Code	Sum_Ridit	Visits per Hour
DS-01	8.8	>100	ZS-01	6.2	30
DS-02	6.2	50	ZS-02	5.4	50
DS-03	5.8	50	ZS-03	5.4	30
DS-04	5.8	50	BG-01	5.2	30
DS-05	8	>100	PZ-01	6.4	50
DS-06	6	20	BZ-01	5.6	30
DS-07	6	20	GW-01	5.8	20
DS-08	6	20	RZ-01	5.8	20
DS-09	6.6	20	YG-01	5.6	30
DS-10	6.4	20	HO-01	5.6	30
DS-11	7.6	>100	LR-01	5.8	50
DS-12	7.6	>100	GP-01	7.4	50
DS-13	5.4	20	LB-01	5.4	20
NK-01	5	20	GN-01	4.6	20
LJ-01	7	50	SH-01	6	30
TO-01	5.6	20	BA-01	6.4	30
TO-02	6	20	BA-02	6	30
TO-03	5.6	20	LW-01	6.4	50
ZG-01	5.2	20	HW-01	5.2	40
HL-01	4.4	20	NO-01	4.6	20
HL-02	5.6	50	SC-01	6	20
DN-01	2.8	20	DO-01	8.8	>100
DG-01	6.2	50	LN-01	5.6	30
DG-02	6.2	50	EL-01	6.2	30
FZ-01	5.8	50	DW-01	5.2	30

3.2. Analyzing Influential Factors of High Riverbank Recreational Areas

A. Exploratory Factor Analysis

Table 5 presents the results of computing the 10 variables of the 50 investigation sites with a correlation matrix. The table reveals that the correlations of four sets of variables achieved the 0.05

significance level (i.e., CW1–CW9, CW4–CW5, CW4–CW9, and CW5–CW6) and the correlation of 15 sets of variables achieved the 0.01 significance level (CW1–CW2, CW1–CW8, CW1–CW10, CW2–CW8, CW2–CW9, CW3–CW4, CW3–CW6, CW3–CW7, CW3–CW9, CW5–CW7, CW6–CW7, CW6–CW9, CW7–CW9, CW8–CW10, and CW9–CW10). Other correlations between the variables did not exhibit statistical significance. Using the Kaiser–Meyer–Olkin (KMO) test, we acquired a KMO value of 0.613 (>0.5), signifying the existence of underlying factors. Therefore, we conducted factor analysis, reduced the variables, and ran a regression on principal component factors to understand the reason for the formulation of underlying factors [34].

Table 5. Correlation coefficient matrix with significance of the CWERAF.

	CW1	CW2	CW3	CW4	CW5	CW6	CW7	CW8	CW9	CW10
CW1	1	0.402 **	0.016	−0.058	0.086	0.049	−0.077	0.464 **	0.340 *	0.533 **
CW 2		1	−0.200	−0.209	0.237	−0.259	−0.044	0.459 **	0.159	0.496 **
CW 3			1	0.374 **	0.020	0.550 **	0.372 **	−0.265	0.656 **	0.060
CW 4				1	0.342 *	0.175	0.243	−0.071	0.360 *	0.116
CW 5					1	−0.294 *	−0.428 **	−0.047	0.170	0.001
CW 6						1	0.569 **	−0.117	0.514 **	0.207
CW 7							1	0.018	0.379 **	0.217
CW 8								1	0.021	0.457 **
CW 9									1	0.449 **
CW 10										1

Note: ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). Kaiser–Meyer–Olkin Measure of Sampling Adequacy (KMO) is 0.613. Bartlett's test of sphericity is very significant at the 0.001 level ($p < 0.001$).

Table 6 displays the computed results of explanatory variance and factor extraction. When the eigenvalue of the unrotated component loading matrix was >1, three components had a total of 70.17% explanatory power over the data, with the highest explanatory power of a single component being 29.00%, followed by 25.32% and 15.84%. After rotation, when the eigenvalue of the component loading matrix was >1, the total explanatory power of the three components was identical to that before rotation, with the highest explanatory power of a single component being 25.52%, followed by 23.32% and 21.32%, thereby indicating that the difference between the explained variances was reduced.

Table 6. The percentage of total variance explained by the CWERAF.

Component		1	2	3	4	5	6	7	8	9	10
Initial Eigenvalues	Total	2.90	2.53	1.58	0.82	0.66	0.43	0.37	0.32	0.21	0.16
	Variance (%)	29.00	25.32	15.84	8.20	6.64	4.35	3.66	3.20	2.14	1.65
	Cumulative (%)	29.00	54.32	70.17	78.37	85.01	89.35	93.01	96.21	98.35	100.00
Extraction Sums of Squared Loadings	Total	2.90	2.53	1.58							
	Variance (%)	29.00	25.32	15.84							
	Cumulative (%)	29.00	54.32	70.17							
Rotation Sums of Squared Loadings	Total	2.55	2.33	2.13							
	Variance (%)	25.52	23.32	21.32							
	Cumulative (%)	25.52	48.84	70.17							

Note: extraction method—principal component analysis.

Table 7 lists the loading of each component factor. Before rotating the component loading matrix, the results were similar to CW4 and thus had low explanatory power. After rotating the component loading matrix, the explanatory power of each variable was strengthened. Therefore, we adopted the component set of the rotated component loading matrix for reference.

Table 7. Factor component loading scores.

	Component [a]			Rotation Component [b]		
	1	**2**	**3**	**1**	**2**	**3**
Aquatic zones	0.292	**0.720** [c]	−0.003	**0.770**	0.105	−0.018
Bike paths	0.018	**0.806**	0.031	**0.768**	−0.090	−0.232
Service center	**0.749**	−0.339	0.225	−0.128	**0.754**	0.375
Entrance image	0.469	−0.187	0.561	−0.102	**0.742**	−0.088
Information boards	−0.086	0.226	**0.902**	0.091	0.490	**−0.790**
Cleaning and maintenance conditions	**0.763**	−0.296	−0.278	−0.028	0.430	**0.749**
Parking lots	**0.671**	−0.206	−0.438	0.048	0.244	**0.789**
Exercise facilities	0.047	**0.744**	−0.248	**0.748**	−0.241	0.012
Overall design plan	**0.855**	0.138	0.253	0.353	**0.778**	0.288
Mass transportation accessibility	0.511	**0.677**	−0.101	**0.804**	0.210	0.200

Note: [a] extraction method: principal component analysis, 3 components extracted. [b] Extraction method: principal component analysis. Rotation method: varimax with Kaiser normalization, rotation converged in 5 iterations. [c] Bold type above absolute value 0.6.

From the table, we extract CW1, CW2, CW8, and CW10; CW3, CW4, and CW9; and CW5, CW6, and CW7 as the component variables for the first factor, second factor, and the third factor, respectively.

We name the first factor the exercise and recreation factor. For recreational parks, exercise facilities should be prioritized and introduced in the site design, such as exercise equipment, ball courts, bike lanes, children's playgrounds, and aquatic zones. In addition, these sites should be located near transit stations and where public transportation is otherwise convenient to attract residents and tourists to visit. Factor two encompasses the overall design plan and entrance image and has an emphasis on developing features within the recreation area and providing comprehensive information on the area. If this factor is successfully implemented, this enables tourists to identify the designers' intentions behind the recreation site design [34]. For example, integrating environmental and ecological education information and environmentally friendly designs into a recreation site design can enhance visitors' impressions of and satisfaction with the site. The third factor is environmental maintenance and service factors. The parking lots and environmental cleanliness of recreation sites directly determine visitors' first impressions of sites. In addition, our findings regarding information boards indicate that the quality and quantity of the information boards were negatively related to factor three. After personally inspecting these information boards, we concluded that boards with inconsistent quality and an excessive number of boards resulted in a site appearing disorganized.

Among the recreation sites, sites DS-01, DS-11, DS-12, DO-01, and GP-01 had the top scores in the exercise and recreational factor. These parks are popular sites, hosting crowds on weekdays and weekends alike and featuring expansive park space, government-subsidized resources, and additional facilities and services to meet the demands of various types of visitors, whether children, adults, or older adults. In addition, these sites have a comprehensive set of exercise facilities that range in intensity to meet the needs of all visitors, thereby attracting residents and tourists to make visits for recreational activities.

Sites DS-01, DS-05, DO-01, LW-01, and LJ-01 are the top five in the overall design plan and entrance image factor, with three of these sites being among the most popular in Taiwan. Due to their beautiful scenery, the sites attract many visitors. Under the combined efforts of the public sector and local nongovernmental organizations, these sites exhibit comprehensive overall design plans and unique entrance images, which enable visitors to feel at ease. In particular, one of the five sites is an education center, where a small building has been built in which commentary and tour guide activities are provided. We observed that the local governments' efforts to create comfortable environments and to incorporate unique entrance images into site designs have been recognized and successful.

Finally, sites DS-01, DS-02, DS-05, EL-01, and BA-01 were the top five in the environmental maintenance and service factor. Valued by public agencies and maintained by volunteer groups, these sites have clean environments and frequently attract tourists. For example, sites DS-01 and DS-02 are not particularly scenic; both are riverbank parks located in urban areas. However, efforts to maintain a clean environment at both sites increase their overall comfort levels. By observing other cases, we concluded that it is insufficient to exclusively rely on the public sector to maintain the environment; a clean environment can only be maintained with the participation of local residents.

B. Feature clusters

After extracting the component factors, we acquired the component factors of each variable and the component factor percentages. However, given the limited research resources, the researchers had some difficulty determining which factors should be prioritized and could not determine whether efforts and resources should be invested exclusively into the factor with the highest explanatory variance or divided and invested into all three factors. This was a difficult decision because component factors and explanatory variance reflect the overall performance of the samples; such analysis concerns past experiences and does not constitute an actual prediction model. Therefore, we first conducted a cluster analysis to cluster the recreational sites and then discussed and analyzed how to enhance the quality of each site according to the basic conditions of each cluster.

First, we conducted a cluster analysis on the 50 high riverbank recreation sites in Taiwan. After clustering the recreation sites according to their features, the results revealed that the features of each cluster may have been caused by differences in funding or limitations imposed by external conditions. Therefore, a separate discussion of each cluster was deemed a more effective method.

Figure 2 displays the cluster analysis results. After clustering the recreation sites into three main clusters, sites DS-01, DS-05, DO-01, and LJ-01 formed one cluster. The main features of this cluster are "popular scenic site" and "high service quality," which enable these recreation sites to attract many visitors. Site DN-01 formed another cluster; the recreation site consists of a geological landscape featuring the exposed sedimentary layer of a high riverbank. The site has unique scenery but lacks fundamental facilities and thus represents a risky tourism site. Finally, the remaining 45 recreation sites constituted a cluster with various features, including exercise facilities, leisure facilities, scenic sites, and bike lanes.

3.3. Logistic Regression Analysis of Factors for Driving Site Popularity

By investigating the number of hourly visitors (CW11) for each recreation site, we determined the attractiveness of each recreation site based on the number of visitors received. To verify the driving relationship and intensity of the component factors for the popularity of the recreation sites, we used the extracted component factors to conduct logistic regression analysis. The analysis results are presented in Table 8.

Table 8. Variables used in the logistic regression (LR).

	Logit Thresholds of H_0								
Variables	**CW11 > 100**	**Sig.**	**Δ odds**	**CW11 > 50**	**Sig.**	**Δ odds**	**CW11 > 20**	**Sig.**	**Δ odds**
F1	2.083	0.019 *	8.03	4.631	0.010 *	102.62	-	-	-
F2	-	-	-	2.540	0.017 *	12.68	2.920	0.009 **	18.54
F3	-	-	-	3.430	0.004 **	30.88	4.058	0.006 **	57.86
Constant	−3.986	0.002 **	-	−0.890	0.091	-	1.529	0.021 *	-

Note: This is the Wald chi-square test that tests the null hypothesis that the constant equals 0. This hypothesis is rejected because the *p*-value (listed in the column called "Sig.") is smaller than the critical *p*-value of 0.05 (or 0.01). Hence, we conclude that the constant is not 0. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

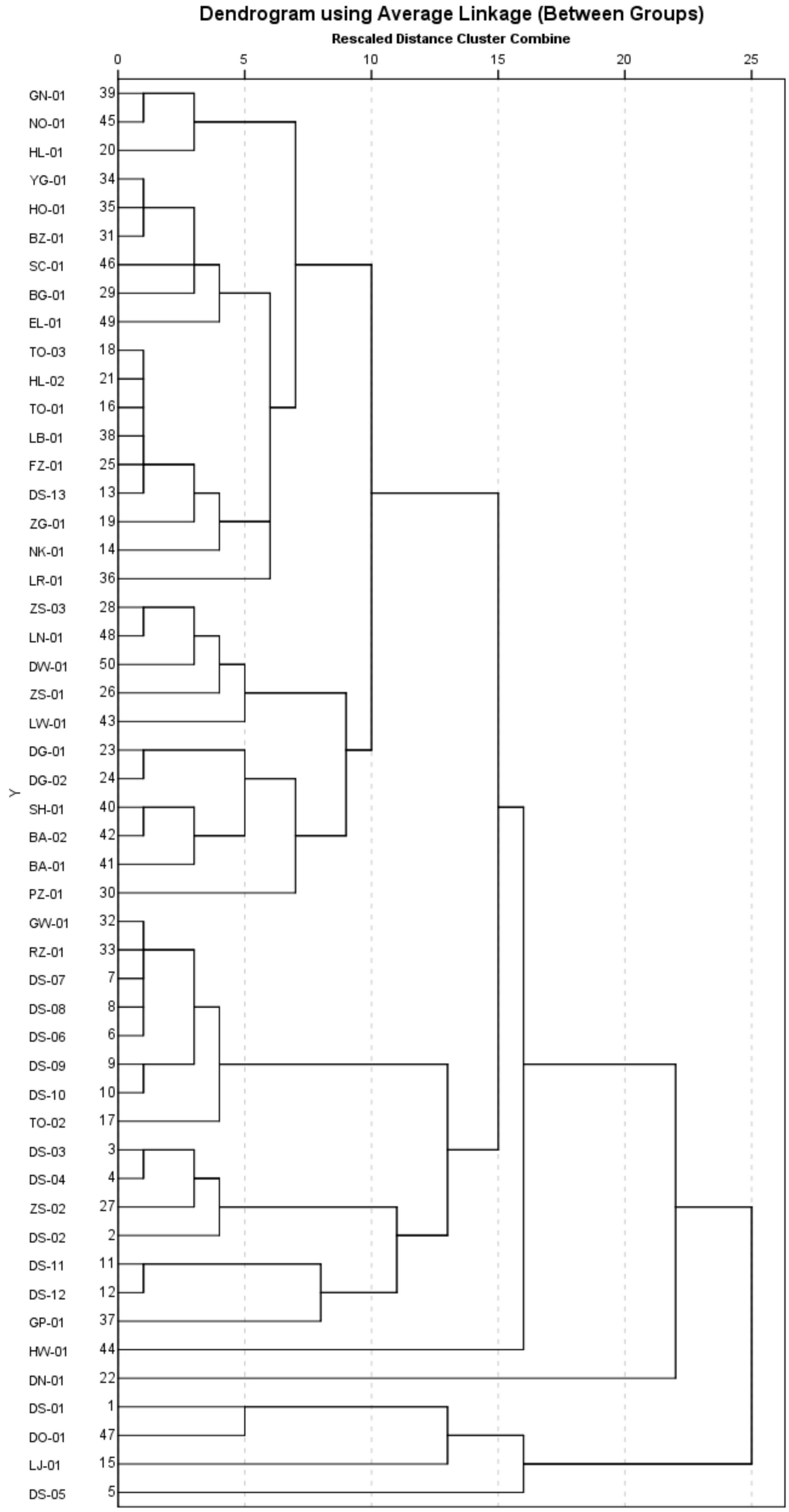

Figure 2. Feature clusters of high riverbanks in Taiwan based on the Comfortable Water Environment Rest Assessment Form.

When the threshold for popular sites was set as "more than 100 hourly visitors (CW11 ≥ 100)," four recreation sites were classified as popular sites, whereas 46 sites were classified as unpopular. Logistic regression results indicated that under this threshold, factor one was a positive driving factor, thereby indicating the exercise and leisure factor is a principal component factor for popular recreation sites.

When the threshold for popular sites was set as "more than 50 hourly visitors (CW11 ≥ 50)," 18 recreation sites were classified as popular, whereas 32 were classified as unpopular. Logistic regression analysis results revealed that under this threshold, factors one, two, and three are positive driving factors. This signifies that exercise and leisure, overall design plan and entrance image, and environmental maintenance and service factors are principal component factors for popular recreation sites.

When the threshold for popular sites was set as "more than 20 hourly visitors (CW11 ≥ 20)," 31 recreation sites were classified as popular, whereas 19 were classified as unpopular. Logistic regression analysis revealed that under this threshold, factors two and three are positive driving factors, suggesting that the overall design plan and entrance image factor and the environmental maintenance and service factor are principal component factors for popular recreation sites. The area under the curve of Equations (1)–(3) is 0.891, 0.951, and 0.944, respectively, all of which are greater than 0.5 and indicate the accuracy of the prediction model. In addition, the odds ratio provides the increments of the odds when the factor loading value is increased by 1.

$$\ln (1/1 - p) = -3.986 + 2.083 \text{ (exercise and leisure factor)} \quad (1)$$

$$\ln (1/1 - p) = -0.890 + 4.631 \text{ (exercise and leisure factor)} + 2.540 \text{ (overall design plan and entrance image factor)} + 3.430 \text{ (environmental maintenance and service factor)} \quad (2)$$

$$\ln (1/1 - p) = 1.529 + 2.920 \text{ (overall design plan and entrance image)} + 4.058 \text{ (environmental maintenance and service factor)} \quad (3)$$

4. Discussion

According to the factor analysis, cluster analysis, and logistic regression analysis, we devised two approaches to improve the use of high riverbank areas.

First, the main type of visitors for each high riverbank area should be clarified. In popular scenic sites, the number of tourists is greater than that of local residents. Relative to local residents, tourists have a higher demand for service quality. For riverbank parks in urban areas, the number of local resident visitors surpasses that of tourist visitors. Since local resident visitors have greater demand for exercise and leisure, these sites can improve their facilities to meet these demands. Furthermore, it is worth noting that due to Taiwan's declining birthrate, Taiwanese families are willing to spend and consume more for the benefit of their children [39,40]. Small families that include young children or older adults constitute a large proportion of visitors. Therefore, overly risky environments or activities may discourage these families from visiting. In addition, the overall design plan and entrance image factor can be enhanced for all recreation sites to strengthen resource allocation.

Second, beautiful scenery, expansive spaces, transportation convenience, and being close to nature are key attractions that prompt visitors to visit high riverbanks. In our study, riverbank parks in urban areas, popular hot springs recreation sites, bike lanes along riverbanks in urban areas, and sites with rural farmland scenery boast beautiful natural scenery and high popularity. Regarding the design plan of the environment and the quality of facilities and services provided in riverbank parks, visitors are concerned with the planning of pedestrian or bike lanes, the pruning of plants and removal of fallen leaves, and the removal of weeds in grasslands. Since construction in high riverbank areas is limited, large trees are rare, resulting in less shade. Therefore, the demands of all age groups should be included in the consideration of tourists' demands for pedestrian and bicycle path planning, which is a key influential factor for visitor comfort [41,42]. Taiwan has convenient railway and highway systems; visitors can take a train or drive to the vicinity of a scenic site and then ride a bicycle or walk to the recreation site. By enhancing the delivery and pick-up functions of mass transportation systems for recreation area surroundings, more visitors may be attracted to engage in aquatic and low-carbon tourism activities in the recreation sites, thereby achieving the practical goal of green tourism. In addition, recreation sites should provide clear details on pedestrian and biking paths and path distances. Recreation sites that provide visitors with clear information enable visitors to engage in recreation activities with ease. Currently, Taiwan has introduced 5G technology and real-time augmented reality facilities in recreation sites to provide visitors with information [43–45].

In particular, the Wulai Old Street scenic area (DS-05) is a high riverbank area that exhibits a higher Ridit score (8 points) and features a hot springs region. The site receives many visitors during the weekend, has a landscape bridge that extends over the riverbank, and features a shopping district beside the bridge. The environment of the recreation site, which is entirely maintained by local residents, features a scenic environment. Therefore, this study posits that the involvement of volunteer groups is a key underlying factor. However, the quantification of this underlying factor is difficult. This study only conducted an assessment and evaluation of one outcome of the recreation sites, namely number of hourly visitors [16,17].

5. Conclusions

This study conducted a large-scale and intensive investigation to establish the CWERAF and to evaluate the cases of Taiwanese riverbank recreational sites. Due to Taiwan's topography, which features steep mountains and rapid-flowing rivers, the government has difficulty utilizing Taiwan's water resources. To date, the government has constructed 109 multipurpose reservoirs, employed construction methods for river governance, and established many dams to control water levels of rivers. The high riverbanks selected in this study provide recreation facilities for citizens year-round. Taiwan has not experienced large-scale, disastrous typhoons from 2017 to the time of this writing in 2020. As a result, Taiwan's high riverbanks have not flooded and their facilities have not been damaged, which has enabled the government to expand the riverbank facilities. We propose that the exercise and recreation factor, overall design plan and entrance image factor, and environmental maintenance and service factor are the factors underlying the use of Taiwan's high riverbanks. We also defined our future avenue of research as: This future study could divide visitors between residents and tourists (out-of-town). Future research may focus the attention not only on considering tourists (out-of-town) or residents for calculating the number of hourly visitors and the site attractiveness, but also study their motivations and leisure barriers in cycling [46]. Finally, the government can conduct cluster classification and visitor analysis and invest resources into these high riverbanks to enhance their recreation value.

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