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APPLICATION OF AHP IN ASSESSING THE DEVELOPMENT OF INTERNATIONAL HOT SPRING TOURIST HOTELS ON INDIGENOUS LANDS

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Abstract. *Most lands reserved for indigenous peoples in Taiwan are located in environmentally sensitive areas, possessing considerable cultural and natural resources with hot springs, thus attracting substantial tourism. International tourist hotels have been established in indigenous lands to meet the demand brought by the rapid development of ecotourism, thus contributing to the innovation of this research. This study conducted an expert questionnaire survey and used the analytic hierarchy process to examine the assessment factors and rankings of the development of international hot spring tourist hotels by the weight evaluated according to the preferential order of developers. Land use was determined to be the most important development assessment factor, followed by industry development, transportation, usage zoning, and land use regulations. The findings of this study can be a reference for international hot spring tourist hotel development in indigenous lands worldwide.*
Keywords: Analytic hierarchy process (AHP), Assessment framework, Indigenous lands, International hot spring tourist hotel, Sustainable tourism

1. **Introduction.** With the service industry booming worldwide in the 21st century, Taiwan has been transformed from a manufacturing economy to a service-oriented one. In addition, encouraged by a 2-day weekend policy, people living in Taiwan pay more attention to their leisure life, particularly to hot spring tourism areas near metropolitan areas [1]. Hot spring tourism has recently become one of the most important recreational alternatives in Taiwan and has the potential to be the most representative recreational activity of the Taiwanese tourism industry. On a conservative estimate, the tourist population in hot spring regions exceeded 15 million in 2004 and many new hot spring hotels have expanded to meet market demand [2]. Hot spring resources are plentiful in Taiwan. Most of them are located in indigenous lands in mountainous areas, which are characterized by high slopes and fragile geology. Most of these areas are located in ecologically sensitive areas upstream of major rivers, protected forests, and conservation areas, as well as areas related to soil and water conservation, water source protection, and river catchment. International tourist hotels exert a large economic effect but also cause a large impact on the local environment. Therefore, the current study investigated the various assessment levels of international hot spring tourist hotel development, and determined the ranking of hot spring hotel evaluation factors to assess the preferential order of development proposals. Section 2 presents a literature review for defining indigenous ecotourism, the assessment

elements of international tourist hotel development in indigenous lands, explanations, and feature descriptions. Section 3 describes the analytic hierarchy process (AHP) research method. Section 4 details and analyzes the assessment results. Finally Section 5 presents the study conclusion and recommendations for development of international hot spring tourist hotels in indigenous lands.

2. **Literature Review.** The development of tourism in lands reserved for indigenous peoples should involve not only consideration of local ecological sensitivities but also the reduction of interference with indigenous societies, especially regarding indigenous cultures. Zeppel [3] defined the key elements of indigenous ecotourism development as follows: (1) ecotourism based on indigenous knowledge systems and values; (2) ecotourism based on promoting indigenous customary practices and livelihoods; (3) ecotourism used to regain rights to access, manage, and use traditional land and resources; (4) ecotourism used to manage cultural property such as historic and sacred sites; (5) taking place under the control and active participation of local indigenous people; (6) including indigenous communities in ecotourism planning, development and operation; (7) managing indigenous cultural property in terms of land, heritage, and resources and (8) negotiating the terms of trade for the use of ecotourism resources, including people. The current study clarified the levels, assessment dimensions, elements, explanations, and feature descriptions of the assessment system for the development of international hot spring hotels in indigenous lands through a literature review, expert interviews, and brainstorming. The assessment level elements are presented and explained in Table 1.

Table 1. Assessment level elements with explanations and feature descriptions

Assessment dimension	Assessment element	Explanation and feature description
D1 Land use	C1 Industry development	Intensity of industry competition, economic benefits, and integration with peripheral economic enterprises
	C2 Transportation	Transportation function, vehicle carrying capacity, travel time efficiency, carbon reduction, traffic accessibility, and degree of rail and road integration
	C3 Usage zoning	Construction planning zone, land use regulations, public-private land, urban-nonurban land, land management units, land size, land acquisition methods, land use changes, and geological factors
	C4 Land use regulations	Appropriateness of relevant public construction laws, including those related to the encouragement of private participation in public projects, project approval, and grant funds
D2 Environmental impact	C5 Environmental regulations	Appropriateness of relevant environmental conservation laws, including environmental impact assessment laws, water conservation regulations, land restoration, water protection, and slopeland management
	C6 Building environment	Building legalization, green buildings, and indigenous culture buildings
	C7 Flora	Rare flora, the conservation of plant species, and landscape plants
	C8 Fauna	Animal landscape, rare flora and fauna, conservation of animal species, and indigenous hunting culture
D3 Public participation	C9 Tribal council	Indigenous people, tribal leaders, tribal organizations, and tribal councils on protected area policy
	C10 Village meeting	Local self-government, villagers in neighborhood systems, and villagers
	C11 Elected representatives	Village chiefs, village representatives, and legislative representative
	C12 Opinion leaders	Village elders, society chairpersons, and environmental groups

3. **Methods.** Multicriteria decision making has broad applications, including the selection and development of suppliers [4], IT management decisions [5], and stock options [6]. Ordering application methods include the Delphi method, similarity aggregation method, technique for order preference by similarity to an ideal solution, and AHP. When rating alternatives, they must be assumed to be independent and rankings should be preserved. When comparing alternatives, they must be assumed to be dependent and rankings may not always be preserved [7]. This study used the AHP as the application method and assumed that each assessment criterion is independent. The AHP has been used in diverse applications including the development of strategies. In the current study [8], the AHP literature was extended by addressing the necessity of prioritizing numerous alternatives exhibiting high heterogeneity [9-11]. The AHP has many advantages over other analysis methods in that it facilitates simplifying complex decision-making problems by decomposing them into hierarchies, and it is sufficiently simple to be understood by non-professionals. Therefore, in this study, we examined the validity of the AHP in evaluating the sustainability of international hot spring tourist hotels in indigenous lands. Generating priorities through an organized decision-making process entails breaking down a decision into several hierarchies according to the following steps [12].

1) Define the decision problem.

2) Identify the factors involved.

3) Establish a hierarchical framework.

4) Design a questionnaire to obtain a paired comparison matrix A. If n factors are compared, then the number of paired comparisons that must be conducted is $n(n-1)/2$. Because of the reciprocal property of paired comparisons, if the ratio between elements i and j is a_{ij}, then the ratio between elements j and i is $1/a_{ij}$. Similarly, the lower triangular matrix of the paired comparison matrix A is the reciprocal of the upper triangular matrix, as shown in Equation (1):

$$A = [a_{ij}] = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} = \begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & \vdots & \vdots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix} \tag{1}$$

where W_i represents the element weight of i; $i = 1, 2, \ldots, n$. a_{ij} represents the relative importance ratio between elements, $i = 1, 2, \ldots, n$; $j = 1, 2, \ldots, n$.

5) Calculate the Eigenvalue and Eigenvector. The geometric mean can be obtained by multiplying elements in every row and then normalizing the value, as expressed in Equation (2).

$$W_i = \frac{\left(\prod_{j=1}^{n} a_{ij}\right)^{\frac{1}{n}}}{\sum_{i=1}^{n}\left(\prod_{j=1}^{n} a_{ij}\right)^{\frac{1}{n}}}, \quad i,\ j,\ = 1, 2, \ldots, n \tag{2}$$

A new eigenvector, W_i, is derived by multiplying the paired comparison matrix A with the obtained eigenvector W_i. Moreover, $\lambda_{\max}$ is obtained by dividing every vector of W_i by the corresponding original vector W_i, and then calculating the arithmetic mean of every derived value:

$$\lambda_{\max} = \frac{1}{n}\left(\frac{W_1'}{W_1} + \frac{W_2'}{W_2} + \cdots + \frac{W_n'}{W_n}\right) \tag{3}$$

6) Execute a consistency test to determine the consistency index ($C.I.$), as expressed in Equation (4). Saaty suggested that the most satisfactory $C.I.$ is < 0.1 and that the highest allowable bias is $C.I. < 0.2$; if the $C.I.$ falls within this range, then consistency is

ensured. This is expressed as follows:

$$C.I. = \frac{\lambda_{\max} - n}{n - 1} \tag{4}$$

where, $\lambda_{\max}$ = the greatest eigenvalue of Matrix A, and n = the number of assessment elements.

In matrices of the same order, the $C.I.$ value-to-random index ($R.I.$) value ratio is referred to as a consistency ratio ($C.R.$), as shown in Equation (5).

$$C.R. = \frac{C.I.}{R.I.} \tag{5}$$

If $C.R. < 0.1$, matrix consistency is satisfactory. All assessment criteria of the same level were evaluated using paired comparisons based on an assessment of the elements from the level above them and rated using a scale from 1 to 9 (Table 2).

Table 2. Fundamental scale of absolute numbers

Intensity of Importance	Definition	Explanation
1	Equal importance of i and j	Two activities contribute equally to the objective.
3	Moderate importance of i over j	Experience and judgment slightly favor one activity over another.
5	Strong importance of i over j	Experience and judgment strongly favor one activity over another.
7	Very strong importance of i over j	An activity is favored very strongly over another; its dominance demonstrated in practice.
9	Extreme importance of i over j	The evidence favoring one activity over another is of the highest possible order of affirmation.
2, 4, 6, 8	For compromise between the above values	Sometimes one needs to interpolate a compromise judgment numerically because there is no good word to describe it.

The positive reciprocal matrices produced from assessment scales 1-9 produce different $C.I.$ values under different orders, and are referred to as the $R.I.$ The $C.I.$ value-to-$R.I.$ value ratio under the same order matrix is referred to as the $C.R.$ value. Here, each $R.I.$ value is an average random consistency indicator. The $R.I.$ value of each order is shown by the average random consistency index in Table 3 [13].

Table 3. Average random consistency index

N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I.	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.58

In addition, when the importance of each order differs, the consistency of the entire level structure may need to be tested. Thus, when a level structure possesses more than two levels, the consistency ratio of the hierarchy (CRH) must be considered. However, this step may be omitted if a weighting system is established. Because this study does not require the consideration of relative importance between different levels, CRH testing is omitted.

4. **Results and Analyses.** This study established assessment system indicators and weightings for international hot spring tourist hotel development in indigenous lands; the decision goal level is the optimal location or the target hierarchy (first level). The assessment hierarchy structure is categorized into land use, environmental impact, and public participation items as the criterion dimensions of the second level, whereas the third order assessment elements include "industry development," "transportation," "usage zoning," "land use regulations," "environmental regulations," "building environment," "flora," "fauna," "tribal council," "village meeting," "elected representatives," and "opinion leaders" as key assessment elements; each assessment dimension comprises four assessment elements. All the assessment dimensions and elements are shown in Figure 1.

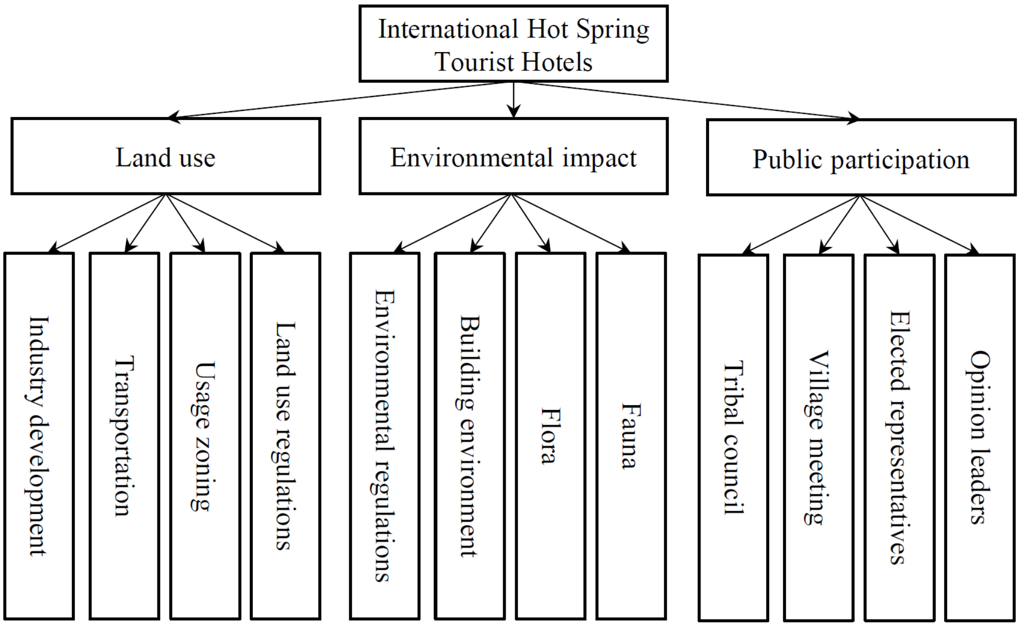

FIGURE 1. Hierarchical model of the assessment system

This study obtained expert opinions from 12 people: three public sector experts, six industry and local opinion leaders involved in the tourism industry and related planning organizations, and three experts from academia specializing in tourism, environmental landscapes, and regional development. Each expert had a sufficient understanding of AHP measurement methods. Focus groups and one-on-one in-depth interviews were utilized to complete questionnaires. The paired comparison questionnaire design adopted in this study (with land use as an example) is shown in Table 4.

The expert questionnaires were processed through group decision making (using geometric means) to construct assessment element pairwise comparison matrices. The results of the assessment element matrix weight calculation by using the assessment elements under land use are shown in Table 5.

Comprehensive calculation of the $C.I.$ and $C.R.$ values of each questionnaire item revealed that they all met the required consistency threshold. The assessment dimension and element weight rankings and comprehensive overall weight ranking calculation results are shown in Table 6.

5. **Conclusion.** The results of this study indicate that land use is the most important development assessment system dimension, with industry development, transportation, usage zoning, and land use regulations being the primary consideration factors for assessing hot spring hotel development. The comprehensive weight rankings of the assessment elements indicate that industry development environmental regulations and land use regulations are the most crucial elements, with industry development exhibiting the highest

Table 4. Paired comparison questionnaire design (with land use as an example)

Item	Absolutely important	Extremely important	Very important	Moderately important	Equally important	Moderately unimportant	Very unimportant	Extremely unimportant	Absolutely unimportant	Item
	9	7	5	3	1	3	5	7	9	
C1 Industry development	☐	☐	☐	☐	☐	☐	☐	☐	☐	C2 Transportation
	☐	☐	☐	☐	☐	☐	☐	☐	☐	C3 Usage zoning
	☐	☐	☐	☐	☐	☐	☐	☐	☐	C4 Land use regulations
C2 Transportation	☐	☐	☐	☐	☐	☐	☐	☐	☐	C3 Usage zoning
	☐	☐	☐	☐	☐	☐	☐	☐	☐	C4 Land use regulations
C3 Usage zoning	☐	☐	☐	☐	☐	☐	☐	☐	☐	C4 Land use regulations

Table 5. Weight calculation example: matrix of assessment elements under land use

	C1	C2	C3	C4
C1	1.00	2.08	1.76	1.69
C2	0.48	1.00	1.03	0.83
C3	0.57	0.97	1.00	1.10
C4	0.59	1.20	0.91	1.00
Weight	0.378	0.193	0.213	0.216

Table 6. Overall weight ranking results

Assessment dimension	Dimension weight	Dimension rank	Assessment element		Element weight	Element rank	Comprehensive weight	Rank
D1 Land use	0.423	1	C1	Industry development	0.378	1	0.160	1
			C2	Transportation	0.193	4	0.082	7
			C3	Usage zoning	0.213	3	0.090	4
			C4	Land use regulations	0.216	2	0.091	3
D2 Environmental impact	0.309	2	C5	Environmental regulations	0.377	1	0.116	2
			C6	Building environment	0.229	2	0.071	8
			C7	Flora	0.182	4	0.056	10
			C8	Fauna	0.212	3	0.065	9
D3 Public participation	0.269	3	C9	Tribal council	0.329	1	0.088	5
			C10	Village meeting	0.321	2	0.086	6
			C11	Elected representatives	0.192	3	0.052	11
			C12	Opinion leaders	0.158	4	0.042	12

comprehensive weight value of 0.160. These results suggest that economic improvement is the primary factor for this issue. Environmental regulations exhibited the second-highest comprehensive weight value of 0.116, indicating that hot spring hotel development requires considering the natural surroundings and ecological environment in addition to potential economic benefit. Land use regulations exhibited the third-highest comprehensive weight value of 0.091. According to Taiwanese indigenous peoples' awareness of autonomy, the comprehensive weight value of the tribal council was 0.088 (fifth most important), indicating that the expectations and opinions of local inhabitants must be respected to prevent conflict. The current results suggest that future research on the related topic requires diverse organizations to achieve group decision making for analyzing differences in opinion regarding assessment dimensions and index weights. This study used an expert questionnaire to obtain expert opinions on the relative importance of the assessed factors, and utilized a pairwise comparison matrix with definite values. The subjective judgments of experts are expressed qualitatively. Future studies may consider using fuzzy semantic expressions to capture the meaning and conclusions of experts more accurately.

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