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Multicriteria Evaluation of Tourism Potential in the Central Highlands of Vietnam: Combining Geographic Information System (GIS), Analytic Hierarchy Process (AHP) and Principal Component Analysis (PCA)

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Abstract: Tourism potential provides an indication for the tourism development opportunities of regions and sites. This paper deals with a multicriteria evaluation of the tourism potential in the Central Highlands of Vietnam. The study area is located in the Southeast Asian monsoon tropical climatic zone, and offers both natural and cultural tourism resources. GIS-based cost distance analysis was used to calculate the travel time along the road and using other transportation networks. Then an Analytic Hierarchy Process (AHP) was applied to determine a weighting coefficient for each criterion in multicriteria evaluation. Principal Component Analysis (PCA) was processed next to AHP, allowing combination of the internal and external tourism potentials of the considered sites. Both AHP and PCA approaches were based on a certain number of alternatives, and take multiple criteria and conflicting objectives into consideration. The results show that the Central Highlands have considerable potential for tourism development at 99 potential eco-tourism sites and 45 potential cultural tourism sites. However, the region is now faced with poor tourism infrastructure with low external potential. An improvement of tourism infrastructure, service quality, and strengthened linkages with other tourist sites is indicated to diversify the tourism products and increase the attractiveness of regional destinations.

Keywords: multicriteria evaluation; tourism potential; GIS; AHP; PCA; Central Highlands; Vietnam

1. Introduction

Vietnam is part of the Southeast Asian monsoon zone. The country stretches over a long narrow territory with various landscapes and seascapes such as mountains, hills, river deltas, coasts, beaches, and sea water bodies. It has a high cultural diversity of 54 ethnic groups, among which the Kinh are the most numerous. Kinh people inhabit both lowlands and uplands, while other ethnic minorities live in the uplands. In Vietnam, tourism development largely depends on the abundance, diversity and quality of the local tourism resources. Combining natural and cultural resources offers a strong basis to develop a unique tourism product [1]. The objective and reasonable evaluation of tourism

resources is important for the development of regional tourism; a multicriteria evaluation is required to calculate real economic values and to implement the sensible use of tourism resources. The difference between internal (intrinsic resources) and external tourism potential (infrastructure and additional services) has been clarified previously [2,3]. The tourism potential of a destination depends on both endowed resources and established resources. Tourism resources, products, and services offered by a destination are the most important aspects defining the attraction for a tourist [4]. Because many aspects contribute to tourism potential [5], selecting the dimensions is the first consideration in a multicriteria evaluation. A multicriteria evaluation of the tourism potential of a site depends on its attraction, carrying capacity, seasonal variability, accessibility, sustainability, tourism infrastructure, and economic benefit [2,6–11]. For example, in China, tourism resources were evaluated according to the classification system of GB/T18972-2003 "classification, investigation and evaluation of tourism resources". This system is structured in two levels: evaluation of a project, and its evaluation factor. The evaluation of a project addresses "the value of resource elements", "influence of resources", and "added value". The evaluation factors include: the value of the resource elements (value of visual, recreational and use; value of historical, culture, scientific and artistic; degree of rarity and fancily; size, abundance and frequency; and integrity), influence of resources (fame, popularity and influence; and travelling time or range of application), and added value (environmental protection and environmental safety) [10]. Sánchez et al. [12] proposed a synthetic methodology to assess the tourism potential of a territory, in a relatively simple but complete and applicable way. Their method considers three basic pillars of tourism: the attractions, supply and demand. In addition, it has been complemented by other territorial elements, such as accessibility [12]. Mikery and Pérez analyzed the research methods used to determine the tourism potential of rural areas and discuss the scope and limitations of these methods [13]. The methods are grouped by dimension (social, economic, environmental) to determine the tourism potential and research paradigms.

Weighting tourism potential criteria is a challenge for a multicriteria evaluation. It is necessary to determine whether all these criteria have the same weight in the evaluation or whether they should be given differentiated weighting coefficients [4]. López established a weighted value for each resource according to demand [14]. Opinion polls and surveys on visitors' preferences make it possible to calculate a weighting coefficient for each group of resources [14]. Reyes and Sánchez weighted geomorphological, plant, and distinctive elements to assess natural tourism potential [15]. The Peruvian Ministry of Foreign Trade and Tourism (MINCETUR, 2006) defined weightings on the basis of quality, accessibility, tourism demands, infrastructure, and uniqueness of the tourist attraction [16]. Cerezo and Galacho calculated the weighted sum of tourism resources, accessibility, and facilities to assess the potential of eco- and adventure tourism [17]. Soria applied a fuzzy procedure to evaluate the tourism potential [18]. In addition, a formula to calculate the tourist potential index was proposed. Multiple indicators for tourism potential are involved and make it possible to properly weight the multiple aspects that have an impact on the tourism potential of an area [4].

The Vietnamese Central Highlands attract tourists based on both natural and cultural resources, especially geo-heritages, biodiversity landscapes, agricultural, and cultural landscapes in which 47 ethnic groups live in a traditional way. Distinct cultures and heritages were found throughout the region: the Central Highlands offer hundreds of cultural, artistic, and architectural identities [19], enabling the development of a range of ecological, resort, religious, cultural, and adventure tours. Innovative improvements in the multicriteria evaluation of the tourism potential in the Central Highlands combine the Geographic Information System (GIS), the Analytic Hierarchy Process (AHP), and Principal Component Analysis (PCA). This approach uses a defined number of alternatives, and considers multiple-criteria objectives. In the international literature, this approach has become a widely used geographical instrument for the multicriteria evaluation of tourism potential [3,20–23].

Analyzing the Central Highlands of Vietnam as a case study, this paper is organized as follows: Section 1 is a literature review, Section 2 describes the study area and data collection; the weighting of

the criteria and the tourism potential results are described in Section 3; and finally, a conclusion and recommendations for tourism investment priorities are addressed in Section 4.

2. Materials and Methods

2.1. Study Area

The Central Highlands are a plateau located West of the Annamite mountains with an altitude ranging 500–800 m on average [19]. The region covers 5 administrative provinces (Kon Tum, Gia Lai, Lam Dong, Dak Lak, and Dak Nong), bordering Laos and Cambodia (Figure 1).

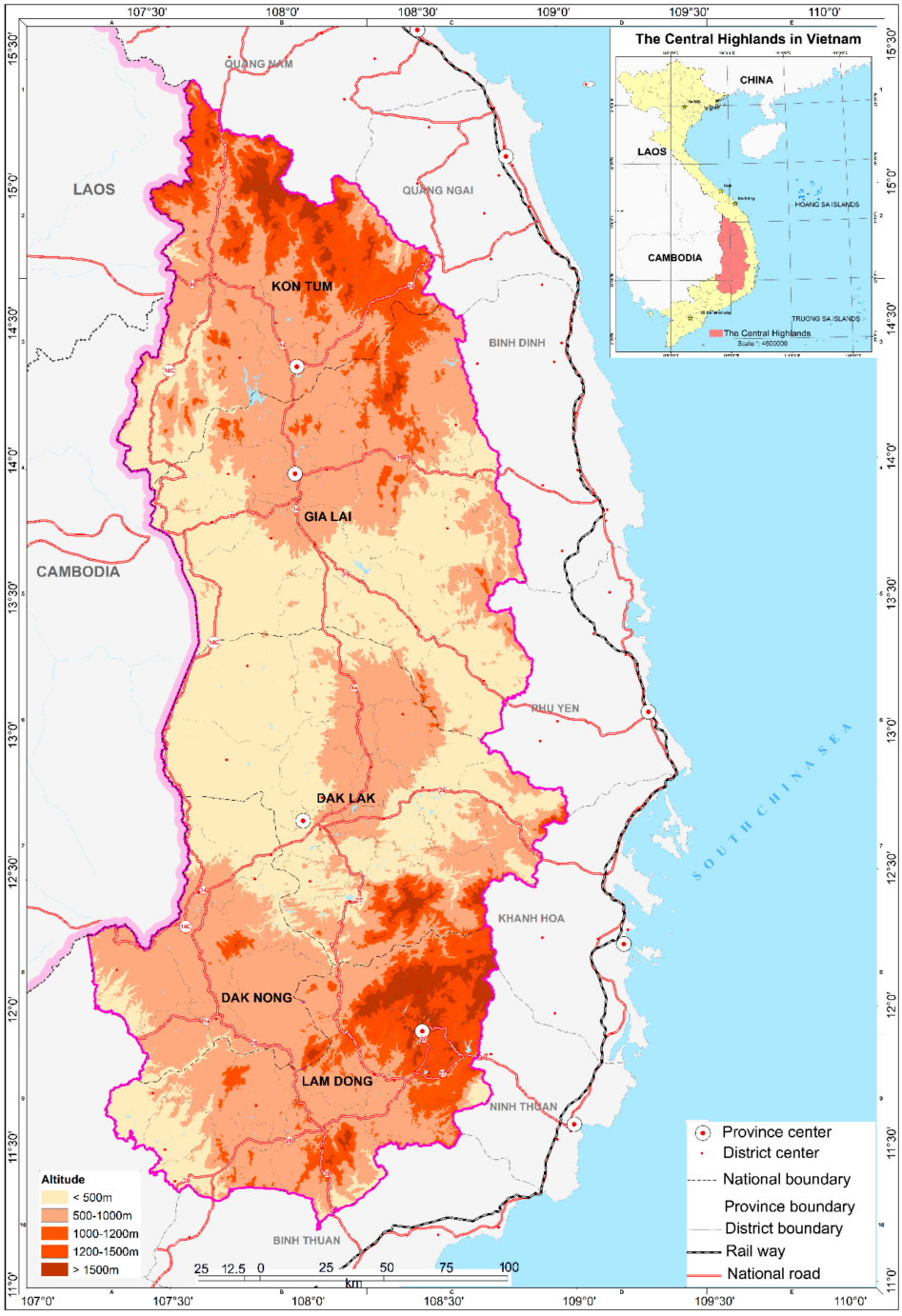

Figure 1. Location of the Central Highlands in Vietnam.

The region has a tropical monsoon climate, basaltic soils, and a flat to gently hilly relief, which is favorable for growing coffee, rubber, and pepper [24]. Evergreen to semi-evergreen broadleaf forest covers almost all areas, except the Yok Don National Park (Dak Lak province), where dry and open deciduous dipterocarp trees dominate [19,24]. This region is the homeland of the Gia-Rai, E-De and the Ba-Na, who traditionally practice shifting cultivation. Since the 1970s, the Kinh have migrated to region as a result of the New Economic Zone Policy of the national government [25]. Migration was driven and fueled by the rapid agricultural development of the Central Highlands, especially through coffee production [26]. Coffee plantations boomed in the Central Highlands during the late 1980s and 1990s thanks to the economic liberalization policy. More recently, rubber and pepper have expanded rapidly all over the region [27,28]. Although the Central Highlands possess the largest cash crop area of Vietnam, the poverty rate and deforestation remain high, especially in the area where ethnic minorities live [29]. Mixed cultural and eco-tourism started in 2010, when the Central Highlands became a key-point tourism region in Vietnam. During the Vietnamese National Tourism Year 2014, the region welcomed approximately 6 million visitors, including 400,000 international ones, generating about 440 million $US in revenue. However, problems in developing and using the tourism resources of the region also appeared, including: missing vertical connections of tourism among the five provinces of the region; lack of tourism infrastructure; and pollution and exhaustion of water caused by mineral mining, affecting the attractive rivers and waterfalls [30]. The multicriteria evaluation of the tourism potential of this region is a necessity.

2.2. Multicriteria Evaluation for Tourism Potential

2.2.1. Selected Criteria

Tourism potential depends on both endowed resources and established resources [2]. Table 1 lists the criteria for assessing the internal and external tourism potential. Also, the categories to which a criterion belongs are shown. In total, 13 criteria are selected: 7 criteria are related to the internal tourism potential (aesthetic and art value, entertainment value, cultural-historical value, scientific value, biodiversity, the size of tourism destination, and tourism seasonality), while 6 other ones are used for evaluating external tourism potential. The latter are related to infrastructure and services (linkages with other tourist sites, accessibility, the distance from tourist attractions to the center, accommodation quality, catering quality, and service labor quality). Based on previous research related to multicriteria evaluation of tourism resources [10,31], 4 assessment scales are classified for each criterion, with rating scores of 10 (very high), 7 (high), 4 (medium), and 1 (low) (Table 1).

Table 1. Selected criteria for tourism potential evaluation of Vietnamese Central Highlands.

Tourism Potential	Selected Criteria	Explanation and References	Evaluation Scale	Rating
Internal potential	Aesthetic and art value (AA)	Aesthetics and art deals with beauty and artistic taste. Tourism aesthetics and art are characterized into philosophical, practical and cultural attributes [6–8,32–34].	Very high High Medium Low	10 7 4 1
	Entertainment value (EN)	From a consumer perspective, the entertainment available at a destination is probably less important than its perceived quality or uniqueness. Even more important for destination competitiveness is the degree to which the entertainment is appropriate for the destination [2,6–9,35].	Very high High Medium Low	10 7 4 1
	Cultural-historical value (CH) Scientific value (SI)	Rating cultural, historical, and scientific value decentralized under the State ranking: province-wide, region-wide, nation-wide, and world-wide attraction [6–8,10,36,37].	World-wide attractive Nation-wide attractive Region-wide attractive Province-wide attractive World-wide attractive Nation-wide attractive Region-wide attractive Province-wide attractive	10 7 4 1 10 7 4 1
	Biodiversity (BI)	Biodiversity value is assessed according to the number of endemic species in protected areas [2,6].	Very high High Medium Low	10 7 4 1
	The size of tourism destination (TD)	The bigger the tourist destination, the higher the tourism carrying capacity [2].	>50 ha >10–50 ha 1–10 ha <1 ha	10 7 4 1
	Tourism seasonality (TS)	Appropriate duration for tourism activities [37].	>300 days per year >200–300 days per year 100–200 days per year <100 days per year	10 7 4 1
External potential	Linkages with other tourist sites (LT)	The density of tourist sites [8].	Very high High Medium Low	10 7 4 1
	Potential accessibility (AC)	Travel time from each tourist site to the accommodations, restaurants, markets, bus stations, and airport [38].	>3 >2–3 >1–2 0–1	10 7 4 1

Table 1. *Cont.*

Tourism Potential	Selected Criteria	Explanation and References	Evaluation Scale	Rating
	The distance from tourist attractions to the city center (DF)	The closer the city center, the higher the potential of the tourist market [4]	<20 km 20–40 km >40–60 km >60 km	10 7 4 1
	Accommodation quality (AQ)	The quality of accommodation is graded using the star ranking of the hotels [2].	Very good Good Medium Bad	10 7 4 1
	Catering quality (CQ) Service labor quality (SL)	Catering quality and service labor quality refers to the statistical yearbooks [2,8].	Very good Good Medium Bad	10 7 4 1

Table 1 shows that the selected criteria are rated using an evaluation scale with 4 scores. For example, rating the cultural-historical and scientific criteria uses increasing values according to the scale of importance: province-wide, region-wide, nation-wide, and world-wide attraction. Aesthetic, artistic and entertainment values are rated at very high, high, medium, and low. The accessibility is an important external tourism potential, which indicates the transport facilities supporting tourists [38]. Potential accessibility is estimated using a GIS-based cost distance analysis, which is determined by the distance from the tourist site to the destinations, public traffic quality and vehicle types. The potential accessibility of tourist sites is calculated as:

$$Access_i = \sum_{k=1}^{5} e^{\left(\frac{-d_{ik}^{b}}{2a^2}\right)} \quad (1)$$

where $Access_i$ is the potential accessibility of tourist site i; d_{ik} is the distance between the center of the ith tourist site and destination kth (k is the closest accommodation, restaurant, market, bus station, and airport); a is the distance to the point of inflection; and b is the distance exponent. The parameters a and b were derived from other studies. We used the same parameter values as the ones applied in the Philippines [39], namely a b value of 2 and a of 45 min.

The cost distance tool of ArcGIS® software version 10.0 (ESRI, Redlands, CA, USA) was used to calculate the travel time along the road and other transportation networks. Figure 2 shows the map of the potential accessibility of the Central Highlands: the highest value is 4.95, the lowest value is about zero. The highest values are found in city centers and along national roads.

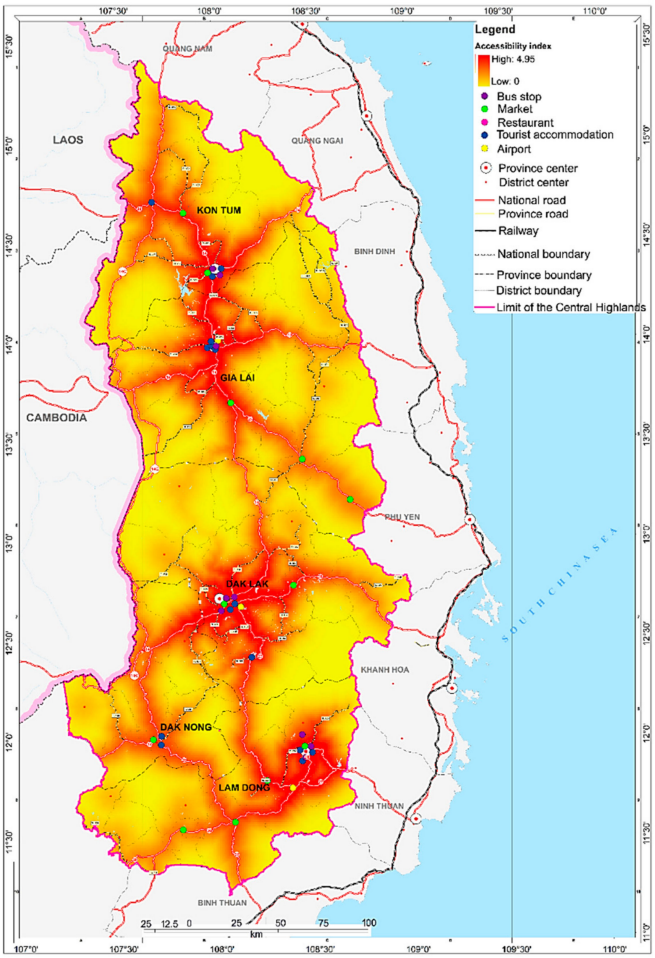

Figure 2. Map of potential accessibility of the Central Highlands of Vietnam.

2.2.2. Analytic Hierarchy Process and Principal Component Analysis

- *Analytic Hierarchy Process (AHP)*

The selected criteria create different effects on the tourism potential of destinations. Therefore, it is necessary to determine weighting coefficients for each criterion in a multicriteria evaluation. In this study, AHP was used to weight the criteria according to the opinions of experts and then we used a Weighted Linear Combination (WLC) for the rating score of the criteria (Table 1). Analytic Hierarchy Process makes it possible to facilitate multicriteria decision-making with respect to environmental impact assessment, landscape assessment, tourism assessment, and economic evaluation [40–43]. This technique decomposes the decisions in the process according to a hierarchical assessment system which includes criteria, sub-criteria, and alternatives [44,45]. The outcomes of AHP are a set of weights reflecting the relative importance of the alternatives. The AHP decomposes the decision problem into criteria and levels according to their common characteristics. The top level is the focus of the problem or ultimate goal; the intermediate levels correspond to criteria and sub-criteria; while the lowest level entails the decision alternatives. If each criterion at each level depends on all the criteria of the upper levels, the hierarchy is complete; otherwise, it is defined as incomplete. The criteria of each level are compared pairwise with respect to a specific criterion in the immediate upper level. Table 2 reports the pairwise comparison scale used in the AHP. It makes it possible to convert qualitative judgments into numerical values, and similar for intangible attributes.

The following judgment matrix is used to calculate the priorities of the criteria:

$$\mathbf{A} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \quad (2)$$

where a_{xy} is the pairwise comparison rating between criterion x and criterion y of a level with respect to the upper level. The entries a_{xy} are subject to the following rules:

$$a_{\mathrm{xy}} > 0; a_{xy} = 1/a_{yx}; a_{xx} = 1 \; \forall \; \mathrm{x} \quad (3)$$

The priorities of the criteria can be estimated by finding the principal eigenvector **W** of the matrix **A** [46]. When vector W is normalized, it becomes the vector of priorities of the criteria of one level with respect to the upper level, as follows:

$$\mathbf{AW} = \lambda_{\max}\mathbf{W} \quad (4)$$

where $\lambda_{\max}$ is the maximum eigenvalue of the matrix **A**.

When the pairwise comparison matrix satisfies transitivity for all pairwise comparisons, it is consistent and verifies the following relation:

$$a_{xy} = a_{xh}a_{hy} \; \forall \; x, y, h \quad (5)$$

Table 2. The Analytic Hierarchy Process (AHP) pairwise comparison scale [46].

Value of a_{xy}	Interpretation
1	x and y are equally important
3	x is slightly more important than y
5	x is more important than y
7	x is strongly more important than y
9	x is absolutely more important than y

AHP allows inconsistency, but provides a measure of the inconsistency in each set of judgments. The consistency of the judgment matrix can be determined by the Consistency Ratio (CR), which is defined as:

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}} \tag{6}$$

where CI is the Consistency Index; RI is the Random Index.

Average consistencies of randomly generated matrices are provided in Table 3 [46,47]. CI for a matrix of order n is defined as:

$$\mathrm{CI} = \frac{\lambda_{\max} - n}{n - 1} \tag{7}$$

A consistency ratio of 0.1 or less is considered acceptable. If the value is higher, the judgments may not be reliable and should be elicited again.

To determine weighted values, 30 experts experienced in tourism, geography, geology, geomorphology, meteorology, landscape ecology, and the Central Highlands were invited for an interview. Experts' opinions ensure conditions for AHP with a CR below 0.1.

Table 3. The average consistencies of random matrices [46,47].

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	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	1.59

Once the weighted values of the criteria are available, in order to measure the potential of tourist sites, each criterion is classified in 4 levels: "excellent" (scores 10), "good" (7), "fairly good" (4), and "poor" (1) (Table 1). According to this classification, the score of each criterion of the individual tourist site is calculated using the following formula:

$$T_{ij} = S_{ij} \times w_j \tag{8}$$

Finally, the total score of each tourist site is calculated with the aid of the formula below:

$$T_i = \sum_{i=1}^{n} S_{ij} \times w_j \tag{9}$$

where T_{ij} is the score of criterion j of the tourism site i (alternative i); T_i is the total score of the tourist site i; w_j is the weighted score of the criterion j; and S_{ij} is the rating score of the criterion number j of tourist site i that is derived from Table 1.

- *Principal Component Analysis (PCA)*

PCA evaluates the tourism potential based on categorical indicators of an ordinal nature. This technique is selected because it is appropriate to each category representing a higher level of potential. PCA makes it possible to visualize and analyze correlations between variables, and to reduce the number of variables in a dataset by combining the variables in components, which allow a better understanding of complex reality. The statistical relations between various criteria are explained through the components. This initial hypothesis is "given a particular value of the component, criteria are independent from each other". This is local independence, and suggests that the relationships between the criteria are due to the relationships existing between each criterion and the component. When a specific value of the component is set, two related criteria become (locally) independent criteria. Components assign a specific value to each of the elements of the sample or the population analyzed. They make it possible to establish the relative position of each criterion on a continuous component scale. The number of observations needed for PCA is at least 50 (cases or number of observations), corresponding to at least 5 times the number of variables [48]. For the case study of the

Central Highlands, the total of 142 observations (142 tourism destinations) and 13 variables meets this requirement of PCA.

The tourism potential was evaluated for 61 districts in the Central Highlands. The score of each individual tourism area is the total score of all tourist sites of the area.

3. Results

3.1. Weighting the Criteria

Table 4 shows the judgment matrix resulting from the expert opinion and the weight scores of each criterion. Internal tourism potential has the highest weight (0.72), which indicates that, to a certain extent, the attractiveness of the resources determines where exploitation can best be carried out. The internal tourism potential is to a large extent determined by the cultural-historical value of the tourist sites (weight score of 0.18), followed by the aesthetic and art, and entertainment and scientific values, which have the same weight scores (0.13). The biodiversity value is third, according to its weight score of 0.09. The external tourism potential has a more limited weight (0.28) than internal tourism potential (0.72). Potential accessibility and quality of the accommodation are more important than other external factors, with weight scores of 0.08 and 0.05, respectively.

Table 4. The judgment matrix gathered from experts' opinions and calculated weight scores of criteria (these are the average values of the experts' valuation).

Criteria	AA	EN	CH	SI	BI	TD	TS	LT	AC	DF	AQ	CQ	SL	Weight Scores
Internal potential														0.72
Aesthetic and art value (AA)	1.0	1.9	0.6	2.5	3.9	6.0	5.6	5.0	3.1	5.4	3.5	3.0	4.8	0.13
Entertainment value (EN)		1.0	0.6	2.9	3.9	5.5	5.6	4.0	3.1	7.2	3.5	3.4	4.6	0.13
Cultural-historical value (CH)			1.0	3.8	5.2	5.8	6.2	5.2	3.7	6.0	4.2	4.2	5.8	0.18
Scientific value (SI)				1.0	3.2	6.2	5.6	5.0	3.1	5.8	4.2	4.4	6.0	0.13
Biodiversity (BI)					1.0	4.5	3.9	2.5	1.4	3.5	3.6	3.8	4.8	0.09
The size of tourism destination (TD)						1.0	1.3	0.8	0.6	2.5	1.5	1.7	1.1	0.03
Tourism seasonality (TS)							1.0	1.3	1.4	3.9	1.4	1.1	0.8	0.03
External potential														0.28
Linkages with other tourist sites (LT)								1.0	0.9	3.2	0.8	2.8	2.4	0.04
Potential accessibility (AC)									1.0	3.8	3.7	3.2	3.3	0.08
The distance from tourist attractions to city center (DF)										1.0	0.8	1.3	1.4	0.03
Accommodation quality (AQ)											1.0	2.0	1.9	0.05
Catering quality (CQ)												1.0	1.9	0.04
Service labor quality (SL)													1.0	0.03

The maximum eigenvalue of the comparison matrix (λ_{max}) = 14.50; Number of factors (n) = 13; Consistency Index (CI) = 0.125; Random Index (RI) = 1.56; Consistency Ratio (CR) = 0.08. The number in bold and italic indicates values of internal and external potentials, which are calculated as the sum of criteria's weight scores.

In general, a CR of 0.08 is acceptable for the evaluation of the tourism potential of the Central Highlands in Vietnam.

3.2. Tourism Potential

3.2.1. Potential of Tourist Sites

A total of 142 tourist sites, including 96 natural and 46 human ones, in the Central Highlands were evaluated for their development potential. With reference to the final results of the multicriteria evaluation, the tourism sites were grouped into 4 geographic levels: Province-wide attractive (scores below 2), Region-wide attractive (2–4), Nation-wide attractive (>4–6), and World-wide attractive (>6–8) [31]. Figure 3 shows the results of this evaluation.

The tourism potential is determined by both internal and external features. The Kaiser-Meyer-Olkin (KMO) is 0.76 and the Bartlett's test of sphericity is significant (Chi-square (Observed value) = 1635, df = 78, $p < 0.0001$), showing that the data fit to the PCA. Two factors were extracted: factor 1 (F1) explains 37.5% of the variation of the variables and represents the external potential;

factor 2 (F2) explains 24% of the variation of the variables and indicates the internal potential (Table 5 and Figure 4).

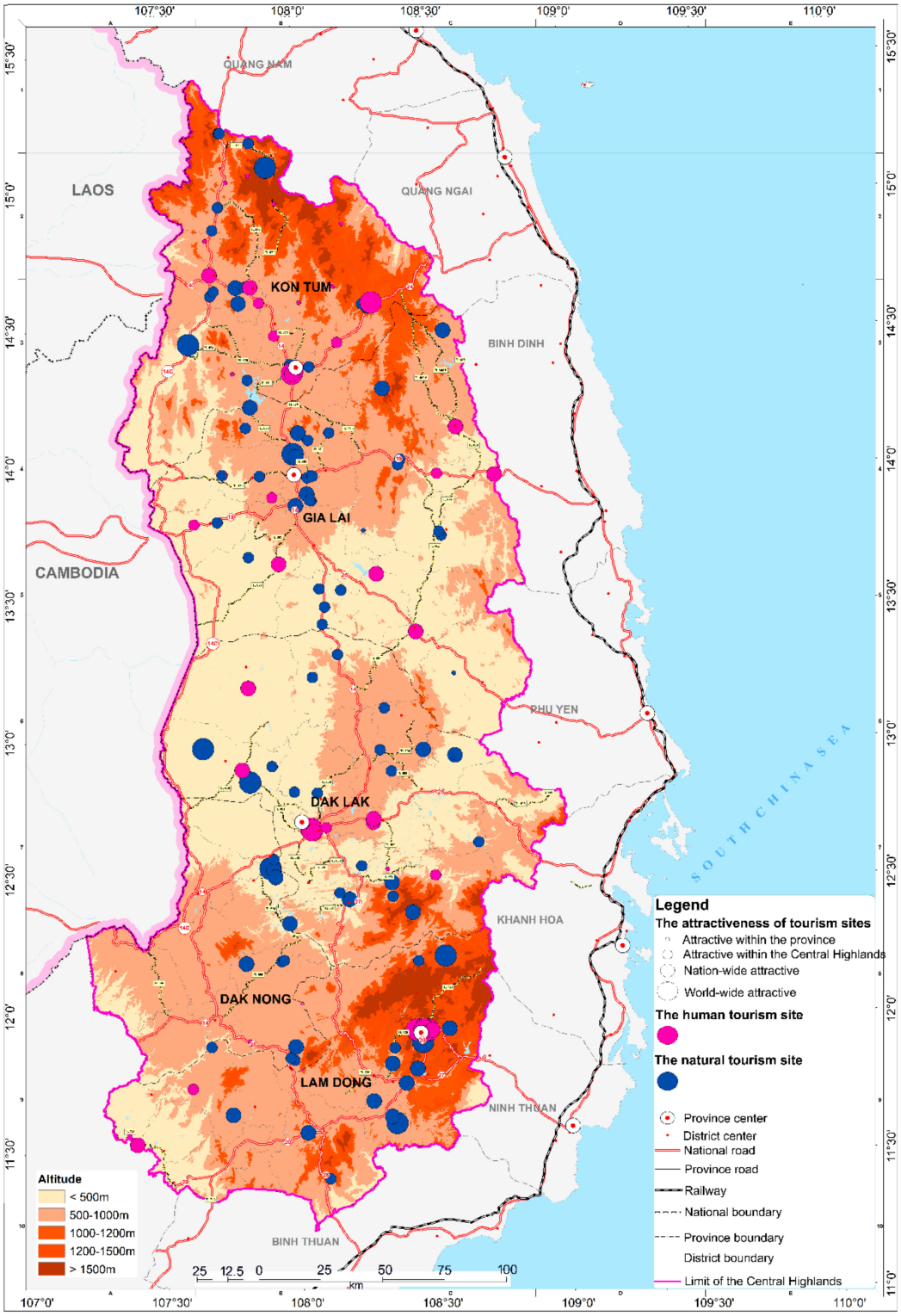

Figure 3. Map of potential for tourism development for the tourist sites in the Central Highlands of Vietnam.

Table 5. Principal Component Analysis (PCA) result with eigenvalue, variability and cumulative of each factor.

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13
Eigenvalue	4.9	3.1	1.3	1.3	0.7	0.5	0.3	0.3	0.2	0.2	0.1	0.1	0.0
Variability (%)	37.5	24.2	10.2	10.0	5.1	3.5	2.6	2.2	1.7	1.2	1.1	0.5	0.2
Cumulative %	37.5	61.7	71.9	81.8	87.0	90.4	93.1	95.3	97.0	98.2	99.3	99.8	100.0

Tourist sites were ranked according to their tourism development score. An unrestricted graded response model was considered and reduced, after eliminating the criteria whose discrimination parameters were detrimental to the reliability of the latent scale constructed, for both the internal and external tourism potential. The position of the tourist sites on this scale is a measure of the relative development potential of each of them. The most interesting part of the tourism potential analysis is the relation between the external and the internal potential. This makes it possible to identify the tourist sites combining internal and external tourism potentials.

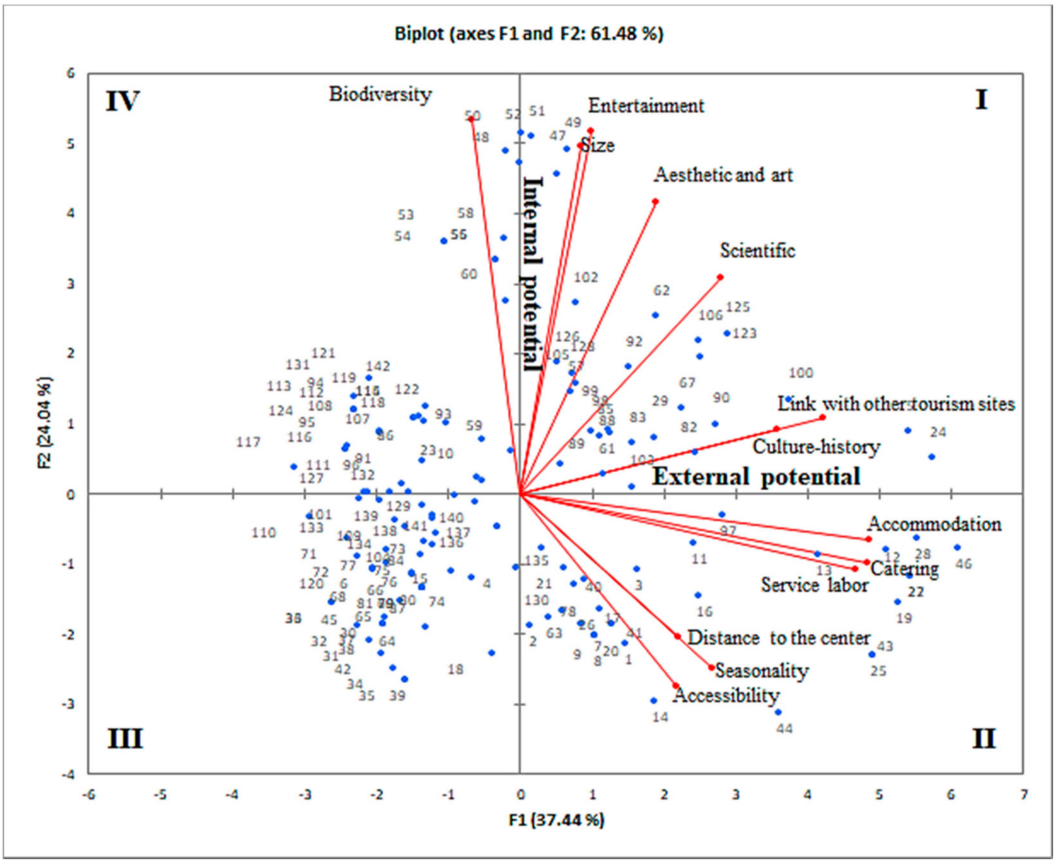

Figure 4. PCA result with correlations between variables and F1, F2 factors for tourism potential; and the internal and external potential of the tourist sites of the Central Highlands of Vietnam (Each blue dot is a tourism site. The names of the tourism sites are shown in Table 6).

Table 6. List of the tourism sites in the Central Highlands region (from 1 to 46 are human tourism sites and from 47 to 142 are natural tourism sites).

Order	Name	Order	Name	Order	Name	Order	Name
1	Kon Tum prison	37	The Dak Pet victory monument	73	Ea Tan	108	Le Kim water fall
2	Dak Glei prison	38	Dak Sieng victory monument	74	Ea Ho	109	Lo O water fall
3	Dak To-Tan Canh victory relic	39	Kon Braih victory relic	75	Ea Drong	110	Suoi Tien water fall
4	Plei Kan victory relic	40	Serepok ferry	76	Ea Ba	111	Xung Khoeng water fall
5	Historical and scenic area of Mang Den	41	Ca Da temple	77	Dak Blao	112	Yang Yung water fall
6	Revolutionary base of Kon Tum People's Committees	42	The cave complex of Khue Ngoc Dien	78	Me Linh	113	Ya Ma water fall
7	Vo Lam temple	43	Buon Ma Thuot war memorial	79	Chu A crater	114	Gou water fall
8	Trung Luong temple	44	1968 Monument	80	Ia Bang crater	115	Ngam water fall
9	Bac Ai temple	45	Hang No victory monument	81	Plei Nh Prong crater	116	Dak R'lung water fall
10	Plei Oi village	46	The Wood-blocks of Nguyen reign	82	Plei Ku crater	117	Bay water fall
11	The Tay Son relic religion	47	Chu Mon Ray national park	83	Bien Ho crater	118	Bim Bip water fall
12	Pleiku prison	48	Kon Ka Kinh national park	84	Ha Bau crater	119	Dray Dlong water fall
13	The Stor resistance village	49	Yor Don national park	85	Hang Rong crater	120	Dray H'Yer water fall
14	The revolution of Zone 9	50	Chu Yang Sin national park	86	Po Drang crater	121	Dray Kpor water fall
15	Dak Po victory relic	51	BiDoup-NuiBa national park	87	Dry crater	122	Thuy tien water fall
16	Victory relic of Road 7-Bo river	52	Ngoc Linh national park	88	Chu Dang Ya crater	123	Seven branches-water fall
17	Plei Me victory relic	53	Kon Cha Rang conservation area	89	Krong Kmar water fall	124	Mo water fall
18	Chu Ty victory monument	54	Ea So conservation area	90	Jraiblian water fall	125	Dray Nur water fall
19	Buon Ma Thuot prison	55	Nam Ka conservation area	91	Nine-floors water fall	126	Tan Canh Cliff of Stone
20	Cocoa plantation	56	Ta Dung conservation area	92	BoBla water fall	127	Pa Sy water fall
21	Dak Tuar cave	57	Ho Lak conservation area	93	Li Liang water fall	128	Ia Ly water fall
22	Lac Giao temple	58	Nam Nung conservation area	94	Dak Che water fall	129	Nhon Hoa water fall
23	Ancient Cham Tower of Yang Prong	59	Dak Uy conservation area	95	Dragon water fall	130	Hiep Thanh water fall
24	Bao Dai Villa	60	DraySap Gia Long conservation area	96	Dak Ke water fall	131	Da Che water fall
25	Da Lat children prison	61	Ngoc Hoi-Dak To Geological Heritage Complex	97	Lieng Rowoa water fall	132	Dak Krong fluvial terrace
26	Loc Bac relic region	62	KonPlong Geomorphological Heritage	98	Pongour seven-floors water fall	133	Dak Mon fluvial terrace
27	Da Lat station	63	Kon Tum Geomorphological Heritage	99	Tiger Cave water fall	134	Dak Xu fluvial terrace
28	Lycee Yersin school	64	Cu M'gra	100	Datanla water fall	135	Tan Canh fluvial terrace
29	Cat Tien holy land	65	Chu Black	101	Princess water fall	136	Dak Bla fluvial terrace
30	H16n revolutionary base	66	Duc Co	102	Dam B'ri water fall	137	Dak Cam fluvial terrace
31	Chư Tan Kra-High Point 995	67	Bien Ho	103	Cam Ly water fall	138	Dak Doa fluvial terrace
32	Dak Ui resistance base	68	K'dang	104	Trinh Nu water fall	139	Ia Le fluvial terrace
33	Xong Dui resistance village	69	La Bang	105	Gia Long water fall	140	Ea H'Leo fluvial terrace
34	Kon H'ring war remnants	70	Ia Pet	106	Dray Sap water fall	141	Dak Xu swamp
35	Peak 601	71	Dak Troi	107	La Nhi water fall	142	Erosion tower formation
36	the Mang But victory monument	72	Nhon Hoa				

Figure 4 shows 4 different groups of tourist sites in the Central Highlands:

- *Tourist sites with a high internal and external potential for tourism development (Group 1)*: These sites are shown in the first quadrant of Figure 4. Rare sites meet both the economic and social requirements for developing tourism. National parks as Yor Don and Chu Mon Ray have a high internal potential and a medium external potential. Other sites, such as the Mang Den scenic area, Bao Dai villa and the Cat Tien sanctuary, have a medium internal potential and high external potential. These sites are suitable for tourism development. However, investment in infrastructure and advertisement are necessary.

- *Tourist sites with a low internal potential, but with a high external potential thanks to a good infrastructure (Group 2)*: These sites are found in the second quadrant of Figure 4. Most of these are cultural sites: The Memorial area of Southward soldiers of Buon Ma Thuot, the Da Lat childrens' prison, the Buon Ma Thuot exile house, the Lac Giao temple, Da Lat railway station, the Wood-blocks of the Nguyen reign, the Stor resistance village, the Tay Son relic religion, 1968 Monument, and the Monuments referring to the revolution of Zone 9.

- *Tourist sites with low internal and external tourism potential (Group 3)*: These sites are shown in the third quadrant of Figure 4. They have few intrinsic attractions and lack complementary tourism services. They are less suitable for tourism development. In the Central Highlands, many tourist sites belong to this group: The Kon Braih victory relic, the Kon H'ring war remnants, the cave complex of Khue Ngoc Dien, Chu Tan Kra-High Point 995, the Mang But victory monuments, the Xop Dui resistance village, the Chu Ty victory monument, the Dak Sieng and Dak Pet victory monuments, and the Dak Ui resistance base.

- *Tourist sites with a high internal potential and a low external potential (Group 4)*: These sites are found in the fourth quadrant of Figure 4. They are the Chu Yang Sin and Kon Ka Kinh national parks. Improving external potential and investing in infrastructure is required to develop tourism in these sites.

3.2.2. Potential of District-Wide Tourism

District-wide tourism is assessed along with the evaluation of tourism site potential. The evaluation score of each district is the total score of all tourist sites within a district. The results of district-wide tourism areas range from 0 to 53. The potential is classified into 5 levels: "no potential" (evaluation scores 0–10), "low potential" (10–20), "medium potential" (20–30), "high potential" (30–40), and "very high potential" (40–53). Figure 5 shows the zones according to their tourism potential. Da Lat city (in the Lam Dong province) shows a very high tourism potential. It is indeed the tourism center of Central Highlands. The second one is Kon Tum city (Kon Tum province), also with high potential. Other districts have medium potential, including Duc Trong (Lam Dong province), Dak Glong (Dak Nong province), Buon Ma Thuot (Dak Lak province), Dak Doa and Pleiku (Gia Lai province) and Dak Glei (Kon Tum province).

The tourism potential shows internal and external aspects. The internal scores range from 0 to 32, and the external scores between 0 and 21. These potentials are classified into 3 levels: low, medium and high. Combining internal and external potential provides a total score covering 6 different types of tourism potential:

Type 1: Medium internal potential and medium external potential;
Type 2: Medium internal potential and low external potential;
Type 3: High internal potential and medium external potential;
Type 4: High internal potential and high external potential;
Type 5: High internal potential and low external potential; and
Type 6: Low internal potential and low external potential.

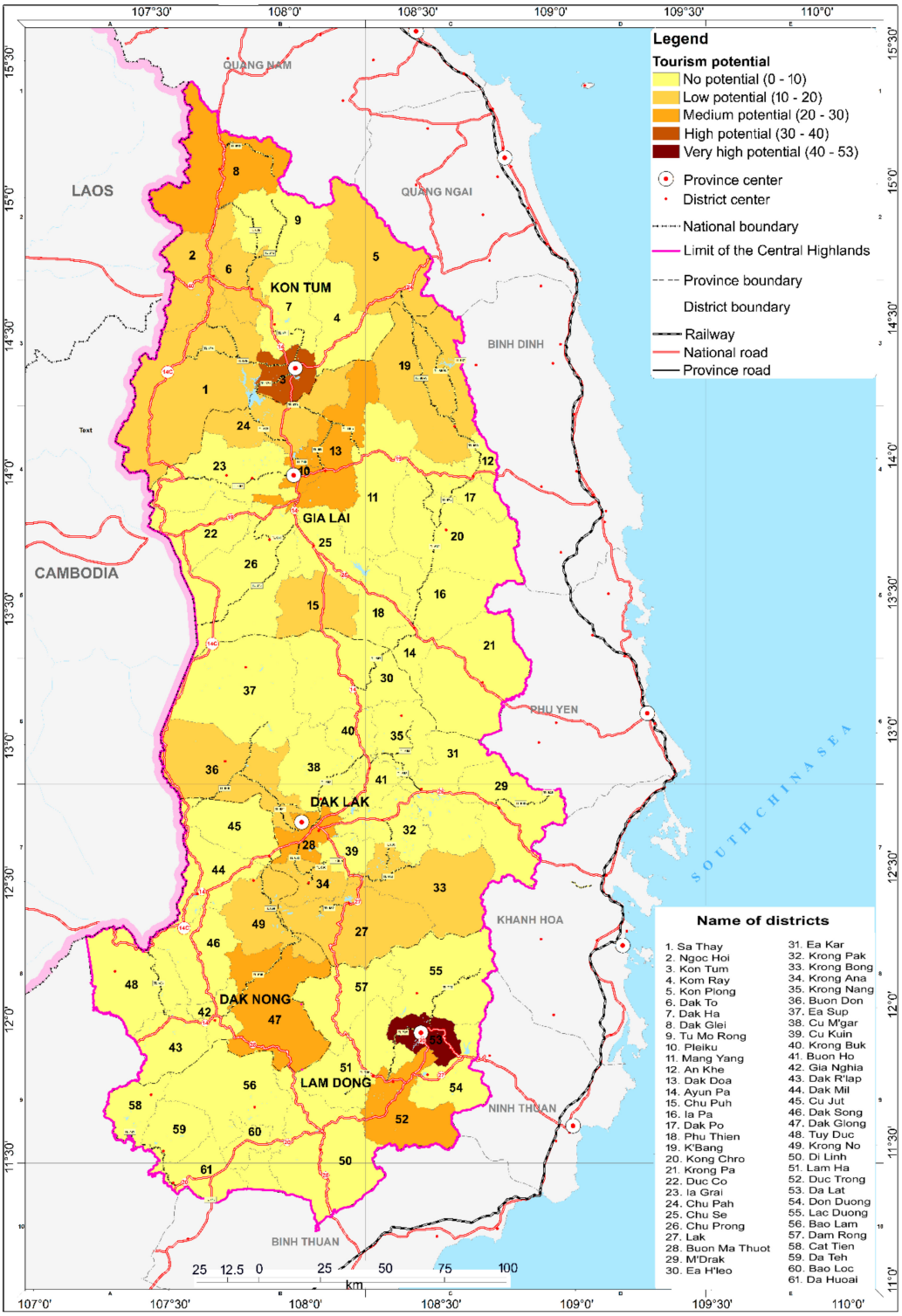

Figure 5. Map of zoning tourism potential of the Central Highlands of Vietnam.

Figure 6 shows the geographic distribution of districts according to this classification. Da Lat city shows a high internal and a high external potential, indicating that the city has the best opportunities to develop tourism. Because Pleiku (Gia Lai province) has high internal potential and a medium external potential, it is an example requiring more tourism infrastructure. Five other districts have a medium rank in internal and external potential: Dak To and Kon Tum (Kon Tum province), Dak

Doa (Gia Lai province), Buon Ma Thuot (Dak Lak province), and Duc Trong (Lam Dong province). Upgrading tourism infrastructure and strengthening the connections with other tourist sites will increase the attraction and diversity of the tourism potential in these districts. Krong Nong and Krong Bong (Dak Lak province) and Dak Glong (Dak Nong province) have high internal potential; however, they lack tourism infrastructure. More investment in tourism infrastructure and upgrading of their tourism services is necessary. Other districts have less potential for tourism development.

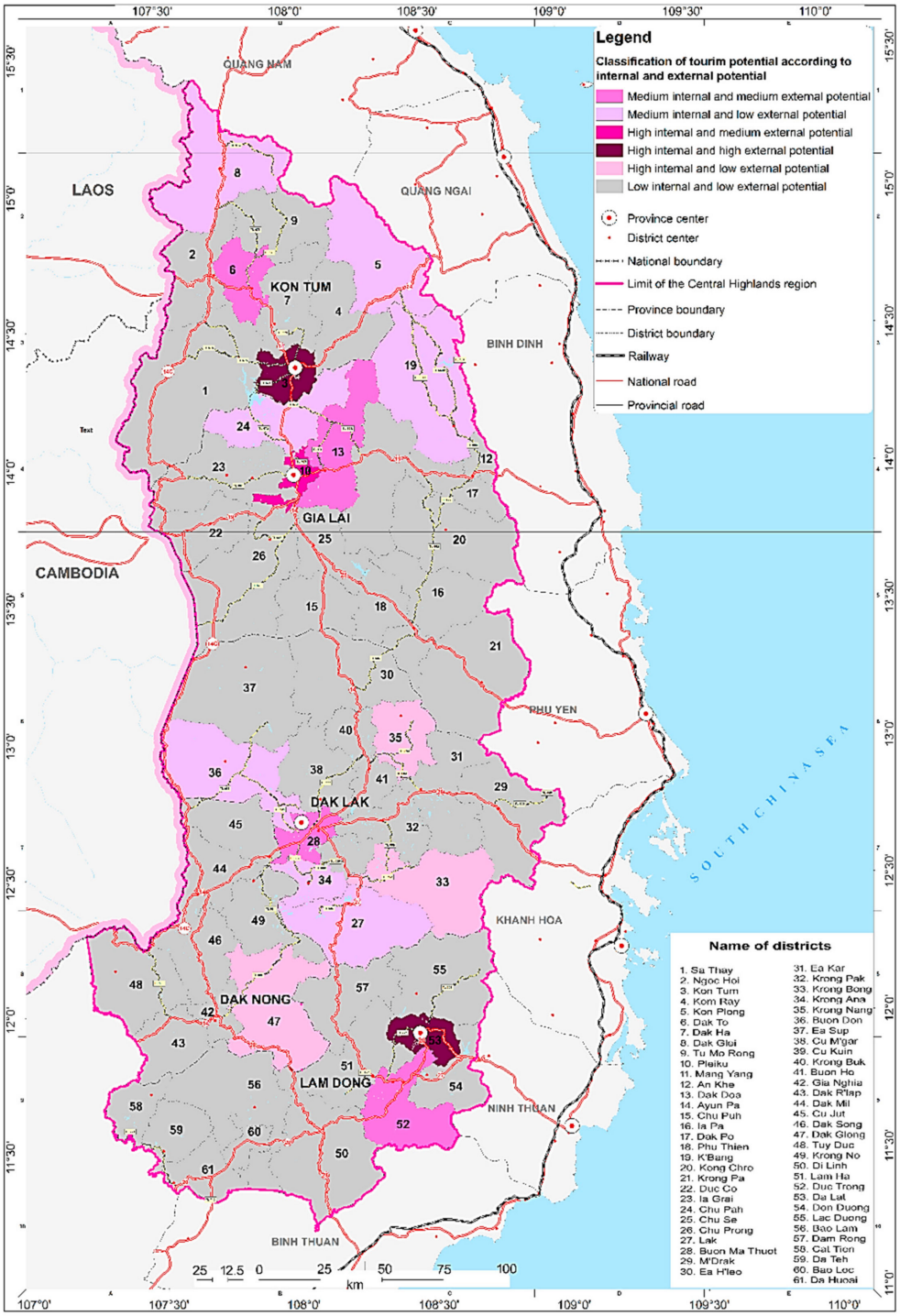

Figure 6. Map of classification of tourism potential by internal and external potential of the Central Highlands.

4. Conclusions and Discussion

While the Central Highlands are emerging as a tourism region in Vietnam, the region was still found to have potential for regional tourism development. A total of 13 criteria were selected for a multicriteria evaluation of the tourism potential of the region. The AHP weight scoring results show that the internal potential is more important than the external potential. Among the internal potential criteria, the cultural and historic value of a site has the strongest influence on the development of tourism, followed by the aesthetic and artistic value, the entertainment value, the scientific value, and the biodiversity. Among the external criteria, accessibility and quality of accommodation are more important than others.

The multicriteria evaluation of the tourism potential by district show that the Central Highlands have several interesting destinations. Da Lat city has the highest tourism potential; it is considered to be the tourism center of the region. Other areas have medium tourism potential: Duc Trong (Lam Dong province), Dak Glong (Dak Nong province), Buon Don and Buon Ma Thuot (Dak Lak province), Dak Doa and Pleiku (Gia Lai province), Kon Tum, Dak To and Dak Glei (Kon Tum province).

Tourism potential supports priority for tourism investments at both regional and district levels [36,49–51]. The development of tourism in the Central Highlands is challenged by several factors. Although the region has potential for developing natural resources, it is still lacking in tourism infrastructure. Table 7 shows that Da Lat city is the only destination in the region with a high score for both the internal and external potential for tourism development. Other districts, such as Pleiku and Dak Doa (Gia Lai province), Dak To (Kon Tum province), Buon Ma Thuot, Krong Nong and Krong Bong (Dak Lak province), Duc Trong (Lam Dong province), and Dak Glong (Dak Nong province), show a high internal potential; however, they have a limited external potential. The PCA results for these destinations point to the necessity of improving the tourism infrastructure and the quality of the service, as well as to strengthen links with other tourist sites to increase the attraction of tourism destinations and diversify the tourism products. Other areas, which have limited potential for tourism development, are not a priority for tourism investment.

Table 7. Priority for tourism investment by listed districts in the Central Highlands.

Group of Districts	Tourism Potential	Priority for Tourism Investment
Da Lat (Lam Dong province)	High internal and high external potential	Most priority for tourism investment
Pleiku (Gia Lai province)	High internal and medium external potential	Priority for tourism investment. Necessary investing more in infrastructure.
Kom Tum and Dak To (Kon Tum province), Dak Doa (Giai Lai province), Buon Ma Thuot city (Dak Lak province) and Duc Trong (Lam Dong)	Medium internal and medium external potential	Priority for tourism investment. Necessary to upgrade the tourism infrastructure, strengthen links with the other tourist sites to increase tourism attraction, and diversify tourism products.
Krong Nong, Krong Bong (Dak Lak province); Dak Glong (Dac Nong province)	High internal and low external tourism potential	Priority for tourism investment. Necessary to attract more tourism investment and improve the quality of tourism services.

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