Neutrosophic Sets and Systems, Vol. 82, 2025

University of New Mexico

Decision Making Model for Analysis of Culinary Intangible Cultural Heritage Tourism Resources: Forest HyperSoft Set and Results

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Abstract: Culinary intangible cultural heritage plays a pivotal role in preserving the authenticity and uniqueness of a region's traditions while serving as a driving force for tourism development. The evaluation of culinary intangible cultural heritage tourism resources is essential to ensure that such traditions are not only recognized but also sustained for future generations. This study presents a comprehensive framework for assessing the value of culinary heritage through multiple criteria, including cultural significance, economic impact, gastronomic appeal, sustainability, and policy support. By utilizing a multi-criteria decision-making (MCDM) approach, this evaluation aims to provide a structured methodology for ranking and analyzing different culinary traditions worldwide. We use the Forest HyperSoft set to divide each criterion as a TreeSoft set. Then in each TreeSoft set we can compute the criteria weights by MEREC method and rank the alternatives by the MARCOS method. This study uses four main criteria and six sub criteria with values. We have four TreeSoft sets. The results are shown in each TreeSoft set.

Keywords: Decision making; Analysis; Culinary Intangible Cultural Heritage Tourism Resources; Forest HyperSoft Set.

1. Introduction

Culinary intangible cultural heritage represents a crucial element of cultural identity, embodying the history, traditions, and social practices of a particular region. Unlike tangible heritage, which includes monuments and artifacts, intangible heritage focuses on traditions, practices, and skills passed down through generations. As globalization accelerates, many unique culinary traditions face the risk of being diluted or forgotten, necessitating strategic evaluation and preservation efforts. Tourism, as a major global industry, has increasingly integrated culinary experiences, making the evaluation of these resources vital for their sustainability[1], [2].

The growing interest in gastronomic tourism has positioned culinary heritage as an asset that contributes to economic development and cross-cultural exchange. Culinary tourism encourages local economies by creating employment opportunities, supporting small businesses, and attracting international recognition. However, despite its potential, not all culinary traditions receive equal attention, leading to disparities in their protection and promotion. A systematic evaluation framework can help identify key factors that determine the sustainability and competitiveness of different culinary traditions[3], [4].

Assessing the value of culinary intangible cultural heritage requires a multidimensional approach that considers both qualitative and quantitative aspects. Cultural authenticity, economic viability, gastronomic appeal, accessibility, and sustainability all play critical roles in determining the long-term success of a culinary tourism resource. Additionally, the role of policies, local community involvement, and global recognition in shaping culinary tourism destinations must be factored into the evaluation. This study proposes a methodological framework to assess these elements and rank culinary traditions based on their overall effectiveness as tourism resources[5], [6].

Incorporating advanced evaluation techniques, such as multi-criteria decision-making (MCDM), enables a structured assessment of culinary heritage by weighing different factors and ranking alternatives based on their performance. MCDM approaches, such as MEREC and MARCOS methods, allow for a data-driven comparison of culinary heritage resources. By applying these methods, this study seeks to bridge the gap between cultural heritage preservation and modern tourism development.

Furthermore, sustainability remains a key concern in the evaluation of culinary intangible cultural heritage. The increasing commercial appeal of traditional foods can lead to over-commercialization, loss of authenticity, and environmental degradation. Thus, a balanced approach that promotes culinary tourism while ensuring responsible consumption and environmental sustainability is essential. This study also considers how factors such as food security, climate change adaptation, and ethical sourcing of ingredients impact the long-term sustainability of culinary heritage resources[7], [8].

Expert weights assigned subjectively have the potential to be very biased and burdensome. As a result, we advise using an objective weighting method for the evaluation values. Usually, several criteria are used by objective weighing systems to calculate weights. The MEREC approach was developed by Keshavarz-Ghorabaee et al.[9] to determine objective weights of qualities by evaluating the effect of removing a criterion on the alternative's overall performance. A criterion has a larger portion of the weight when its removal has a bigger effect on the overall performance.

To solve different MCDM situations, the MEREC technique has been expanded to several uncertainties. The relative weights rise by increasing distance from the common perspective and fall with decreasing distance from the common perception. The individual determination criterion weights and the performance of alternatives to the deletion criteria are causally related. For this MCDM problem, no researchers have used MEREC[10], [11].

2. MEREC-MARCOS Model

We evaluate the alternatives of this study by applying the decision-making model. This decision-making model has two main steps. In the first step, we compute the criteria weights by the MEREC method and ranking the alternatives by the MARCOS method.

The steps of the MEREC method are organized as follows:

Establish the evaluating matrix.

Different experts and decision makers are evaluated a set of criteria and alternatives.

Obtain the overall evaluation matrix.

We obtain the overall evaluation matrix by combining the decision matrices into a single matrix between criteria and alternatives.

Standardize the overall evaluation matrix.

We can standardize the overall evaluation matrix such as:

$$y_{ij} = \frac{x_{ij}}{\min_i x_{ij}}; i = 1, \dots m; j = 1, \dots n \quad (1)$$

Where x_{ij} refers to the value in the overall evaluation matrix.

Determine the overall performance of each alternative.

We can compute the overall performance by non-linear function such as:

$$Q_i = \ln\left(1 + \left(\frac{1}{n}\sum_{j=1}^{n}\left|\ln y_{ij}\right|\right)\right) \quad (2)$$

Calculate the performance of the program after deleting each criterion

$$U_i = \ln 1 + \left(\frac{1}{n}\sum_{l=1, l\neq j}^{n}\left|\ln y_{ij}\right|\right) \quad (3)$$

Assess the combined of deviations from absolute values.

$$T_j = \sum_{i=1}^{m}|U_i - Q_i| \quad (4)$$

Compute the criteria weights.

$$W_j = \frac{T_j}{\sum_{j=1}^{n} T_j} \quad (5)$$

Sorting the alternatives.

Then we apply the steps of the MARCOS method[12], [13] such as:

Standardize the decision matrix

The decision matrix is standardized for the benefit and cost criteria such as:

$$h_{ij} = \frac{x_{ij}}{\max_i x_{ij}} \quad (6)$$

$$h_{ij} = \frac{x_{ij}}{\min_i x_{ij}} \quad (7)$$

Form the weighted standardized decision matrix

$$k_{ij} = W_j h_{ij} \quad (8)$$

Calculate the utility digress of alternatives

$$V_i^+ = \frac{S_i}{\max_i S_i} \quad (9)$$

$$V_i^- = \frac{S_i}{\min_i S_i} \quad (10)$$

$$S_i = \sum_{j=1}^{n} k_{ij} \quad (11)$$

Compute the utility function

$$f(V_i) = \frac{V_i^+ + V_i^-}{1 + \frac{1 - f\left(V_i^+\right)}{f\left(V_i^+\right)} + \frac{1 - f\left(V_i^-\right)}{f\left(V_i^-\right)}} \quad (12)$$

$$f(V_i^+) = \frac{V_i^-}{V_i^+ + V_i^-} \quad (13)$$

$$f(V_i^-) = \frac{V_i^+}{V_i^+ + V_i^-} \quad (14)$$

Forest HyperSoft Set

Let U be a universe of discourse and H is a non-empty subset of U, Q be a set of criteria. Each of the criteria has various levels.

Level 1 be the sub criteria values.

Level 2 be the sub-sub criteria values.

Level 3 be the sub-sub-sub criteria values.

Level 4 be the sub-sub-sub-sub criteria values.

Level n be the n-sub criteria values.

Each of these criteria can form the TreeSoft set and these TreeSoft are combined to form the Forest HyperSoft set[14].

We can define the Forest HyperSoft as:

$$G: P\big(Forest(Q)\big) \rightarrow P(H) \quad (15)$$

3. Application of the Proposed Framework

This section shows the results of the proposed approach. In this study we have four main criteria and nine alternatives. So, we divide the four main criteria into four TreeSoft sets. In each TreeSoft we can compute the criteria weights and ranking the alternatives. Fig 1 shows the classification of the criteria.

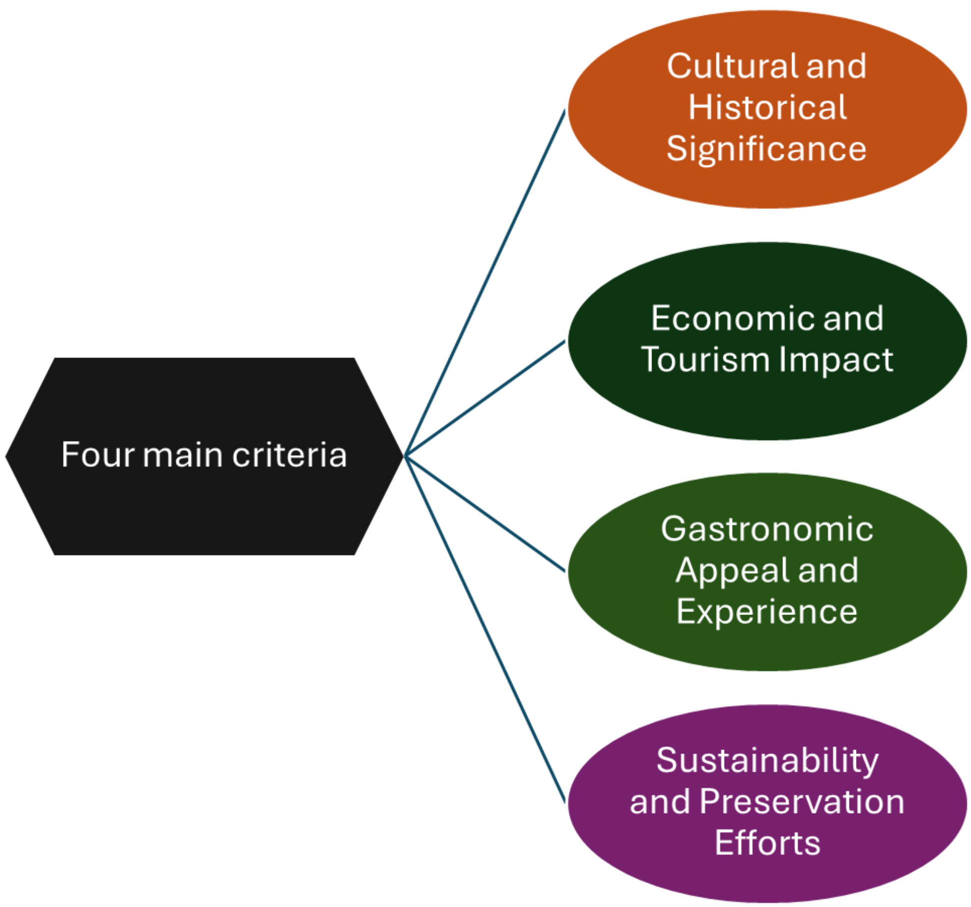

Fig 1. Classification of the main criteria.

Then we apply the MEREC and MARCOS method in each criterion.

First criterion

We established the evaluating matrix. Three experts evaluate the criteria and alternatives using a scale between 0.1 to 0.9. This criterion has three sub-criteria as shown in Fig 2.

We obtained the overall evaluation matrix using the average method.

We standardized the overall evaluation matrix using Eq. (1) as shown in Table 1.

We determined the overall performance of each alternative using Eq. (2).

Then we calculate the performance of the program after deleting each criterion using Eq. (3).

Then we assessed the combined of deviations from absolute values using Eq. (4).

Then we computed the criteria weights using Eq. (5) as shown in Fig 3.

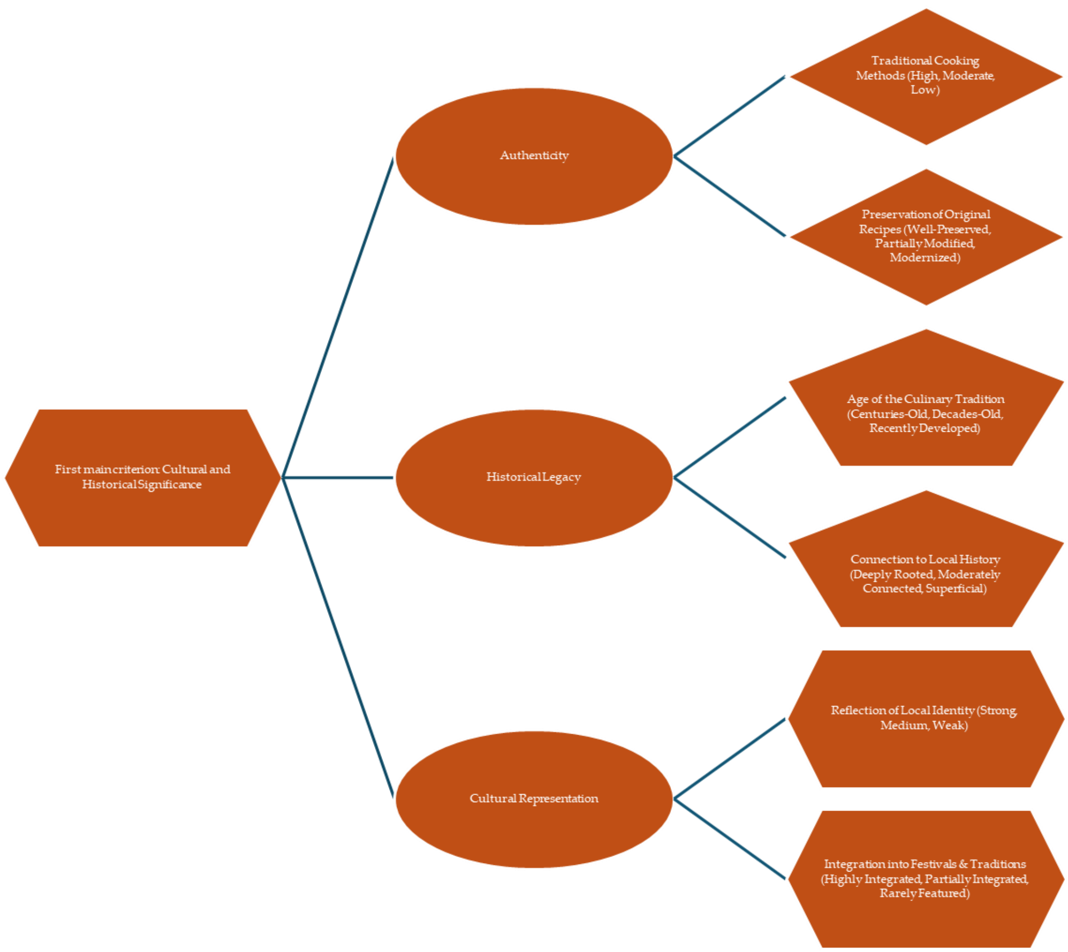

Fig 2. Classification of first criterion.

Table 1. Scandalized matrix.

	C_{1111}	C_{1121}	C_{1211}	C_{1221}	C_{1311}	C_{1321}
A_1	1.521523	1.290475	1.149151	1	1.258466	1
A_2	1.596351	1	1.484866	1.393295	1.404326	1.292269
A_3	1.120481	1.074638	1.149151	1	1.202264	1
A_4	1	1.420902	1.168068	1.664759	1.404326	1.201508
A_5	1.074575	1.242427	1	1.079677	1.258466	1.301808
A_6	1.28939	1.16863	1.288717	1.483601	1.561003	1.02989
A_7	1.596351	1.196903	1.298386	1.443082	1	1
A_8	1.166555	1.243689	1.120481	1.342328	1.437784	1.241755
A_9	1.484866	1.355268	1.428704	1.463251	1.112605	1.131098

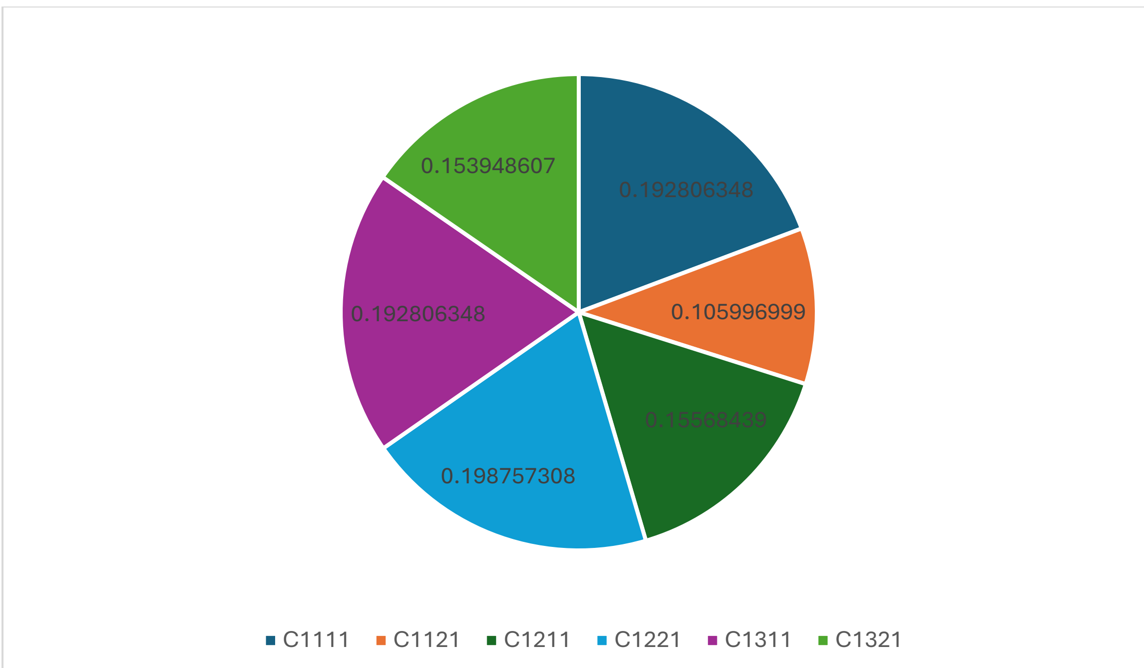

Fig 3. Weights of the first criterion.

We applied the MARCOS method to obtain Standardize the decision matrix using Eq. (6) as shown in Table 2.

Then we formed the weighted standardized decision matrix using Eq. (8) as shown in Table 3.

Then we calculated the utility digress of alternatives using Eqs. (9-11).

Then we computed the utility function using Eqs. (12-14). Then we ranked the alternatives in Fig 4.

Table 2. Scandalized matrix by MARCOS.

	C_{1111}	C_{1121}	C_{1211}	C_{1221}	C_{1311}	C_{1321}
A_1	0.953126	0.908208	0.773909	0.600688	1.240402	0.768162
A_2	1	0.703778	1	0.836935	1.111567	0.992672
A_3	0.701901	0.756307	0.773909	0.600688	1.298386	0.768162
A_4	0.626429	1	0.786649	1	1.111567	0.922953
A_5	0.673145	0.874393	0.673461	0.648548	1.240402	1
A_6	0.807711	0.822456	0.867901	0.891181	1	0.791123
A_7	1	0.842355	0.874413	0.866841	1.561003	0.768162
A_8	0.730763	0.875281	0.754601	0.80632	1.0857	0.95387
A_9	0.930163	0.953808	0.962177	0.878957	1.403016	0.868867

Table 3. Weighted scandalized matrix.

	C_{1111}	C_{1121}	C_{1211}	C_{1221}	C_{1311}	C_{1321}
A_1	0.183769	0.096267	0.120485	0.119391	0.239157	0.118258
A_2	0.192806	0.074598	0.155684	0.166347	0.214317	0.152821
A_3	0.135331	0.080166	0.120485	0.119391	0.250337	0.118258
A_4	0.120779	0.105997	0.122469	0.198757	0.214317	0.142087
A_5	0.129787	0.092683	0.104847	0.128904	0.239157	0.153949
A_6	0.155732	0.087178	0.135119	0.177129	0.192806	0.121792
A_7	0.192806	0.089287	0.136132	0.172291	0.300971	0.118258
A_8	0.140896	0.092777	0.11748	0.160262	0.20933	0.146847
A_9	0.179341	0.101101	0.149796	0.174699	0.27051	0.133761

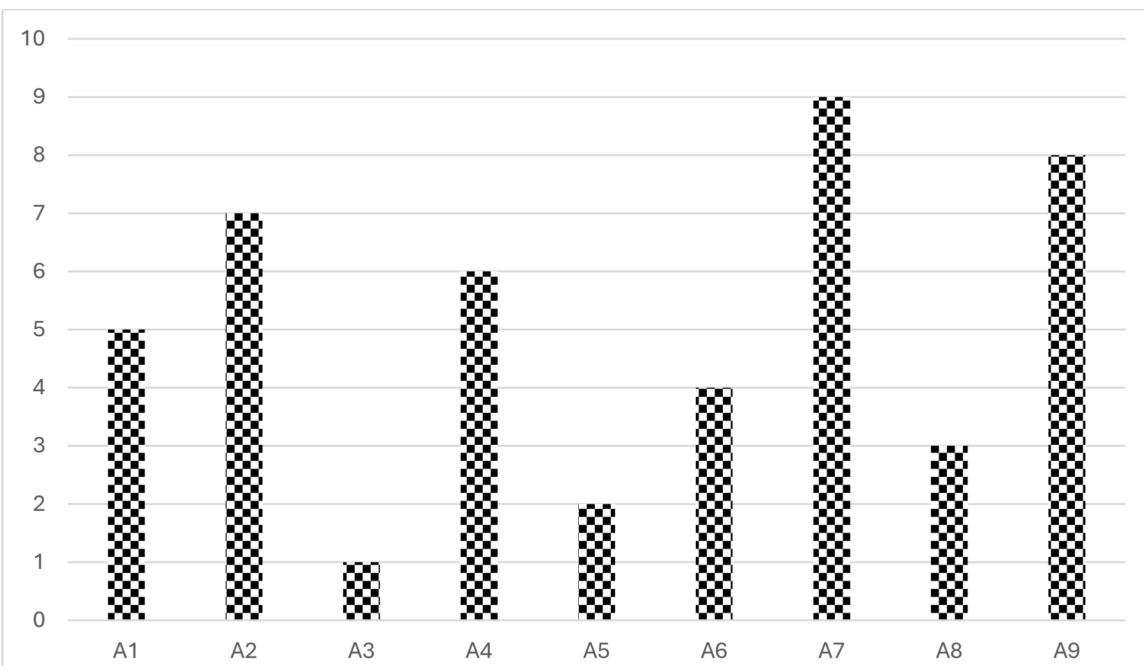

Fig 4. The ranks of the alternatives.

Second criterion

We established the evaluating matrix. Three experts evaluate the criteria and alternatives using a scale between 0.1 to 0.9. This criterion has three sub-criteria as shown in Fig 5.

We obtained the overall evaluation matrix using the average method.

We standardized the overall evaluation matrix using Eq. (1) as shown in Table 4.

We determined the overall performance of each alternative using Eq. (2).

Then we calculate the performance of the program after deleting each criterion using Eq. (3).

Then we assessed the combined of deviations from absolute values using Eq. (4).

Then we computed the criteria weights using Eq. (5) as shown in Fig 6.

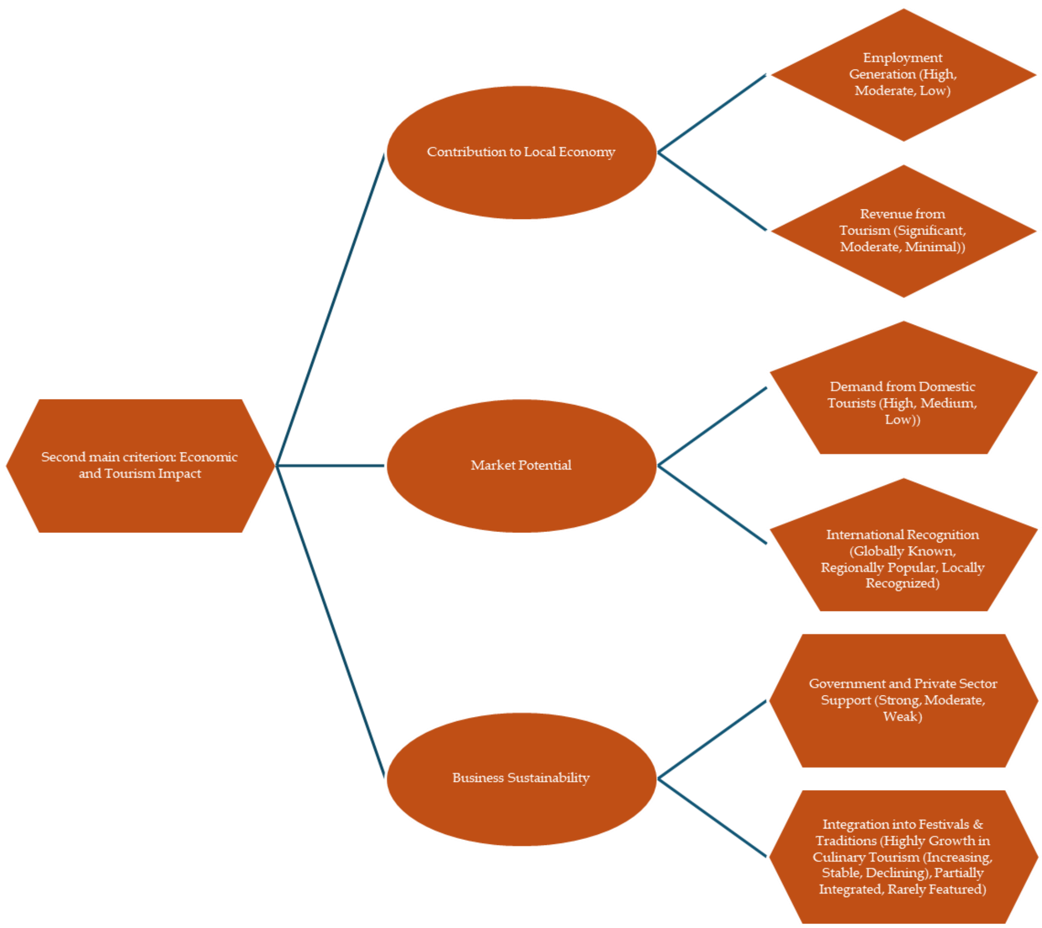

Fig 5. Classification of second criterion.

Table 4. Scandalized matrix.

	C_{2111}	C_{2121}	C_{2211}	C_{2221}	C_{2311}	C_{2321}
A_1	1.416706	1.315266	1.78317	1.000909	1.418157	1.201508
A_2	1.486379	1.228902	2.30411	1.53551	1.835175	1.543836
A_3	1.173634	1.628388	2.30411	1.52487	2.087254	1.160534
A_4	1	1	2.563601	1	1.783233	1.1003
A_5	1.104744	1.038679	1	1.26289	1	1.160534
A_6	1.313136	1.191081	1.725375	1.302992	1.506436	1.1003
A_7	1.225536	1.048285	2.101239	1.313176	1.581957	1.261743
A_8	1.173399	1.143825	1.738682	1.343548	1.328967	1.059962
A_9	1.382574	1.381304	1.927593	1.464581	1.253787	1

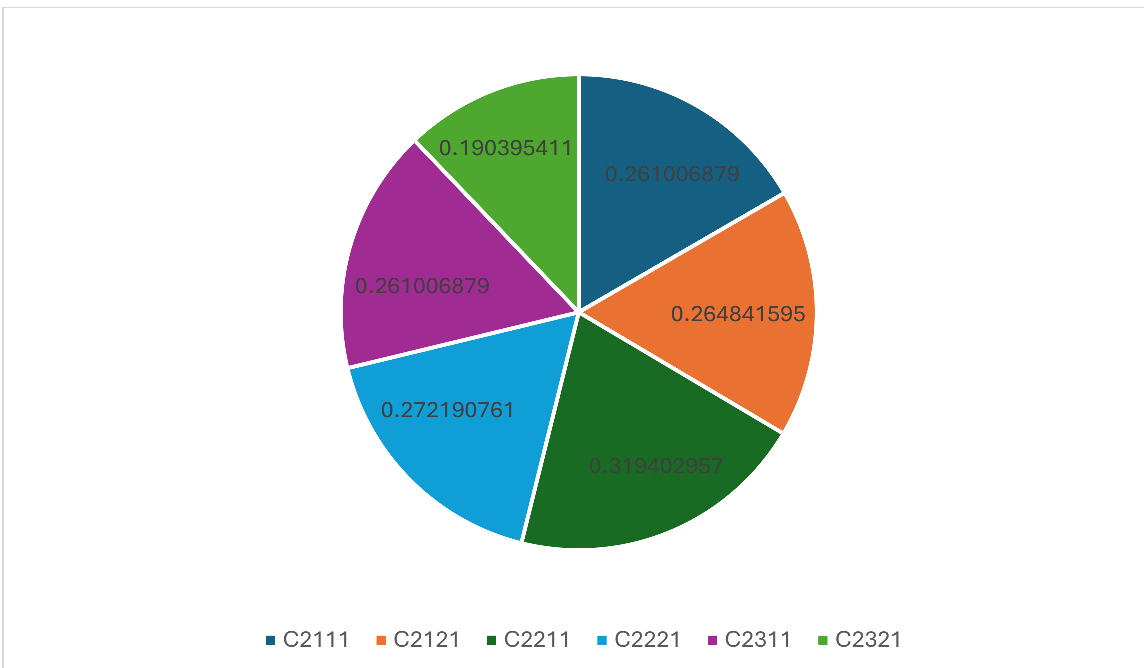

Fig 6. Weights of the second criterion.

We applied the MARCOS method to obtain Standardize the decision matrix using Eq. (6) as shown in Table 5.

Then we formed the weighted standardized decision matrix using Eq. (8) as shown in Table 6.

Then we calculated the utility digress of alternatives using Eqs. (9-11).

Then we computed the utility function using Eqs. (12-14). Then we ranked the alternatives in Fig 7.

Table 5. Scandalized matrix by MARCOS.

	C_{2111}	C_{2121}	C_{2211}	C_{2221}	C_{2311}	C_{2321}
A_1	0.953126	0.807711	0.695573	0.651842	1.471807	0.778262
A_2	1	0.754674	0.898779	1	1.13736	1
A_3	0.789593	1	0.898779	0.993071	1	0.751721
A_4	0.672776	0.614104	1	0.65125	1.170489	0.712705
A_5	0.743245	0.637857	0.390076	0.822456	2.087254	0.751721
A_6	0.883447	0.731448	0.673028	0.848573	1.385558	0.712705
A_7	0.824512	0.643756	0.819644	0.855205	1.319412	0.817278
A_8	0.789435	0.702428	0.678219	0.874985	1.570584	0.686577
A_9	0.930163	0.848265	0.751908	0.953808	1.664759	0.647737

Table 6. Weighted scandalized matrix.

	C_{2111}	C_{2121}	C_{2211}	C_{2221}	C_{2311}	C_{2321}
A_1	0.248772	0.213915	0.222168	0.177425	0.384152	0.148177
A_2	0.261007	0.199869	0.287073	0.272191	0.296859	0.190395
A_3	0.206089	0.264842	0.287073	0.270305	0.261007	0.143124
A_4	0.175599	0.16264	0.319403	0.177264	0.305506	0.135696
A_5	0.193992	0.168931	0.124592	0.223865	0.544788	0.143124
A_6	0.230586	0.193718	0.214967	0.230974	0.36164	0.135696
A_7	0.215203	0.170493	0.261797	0.232779	0.344376	0.155606
A_8	0.206048	0.186032	0.216625	0.238163	0.409933	0.130721
A_9	0.242779	0.224656	0.240162	0.259618	0.434513	0.123326

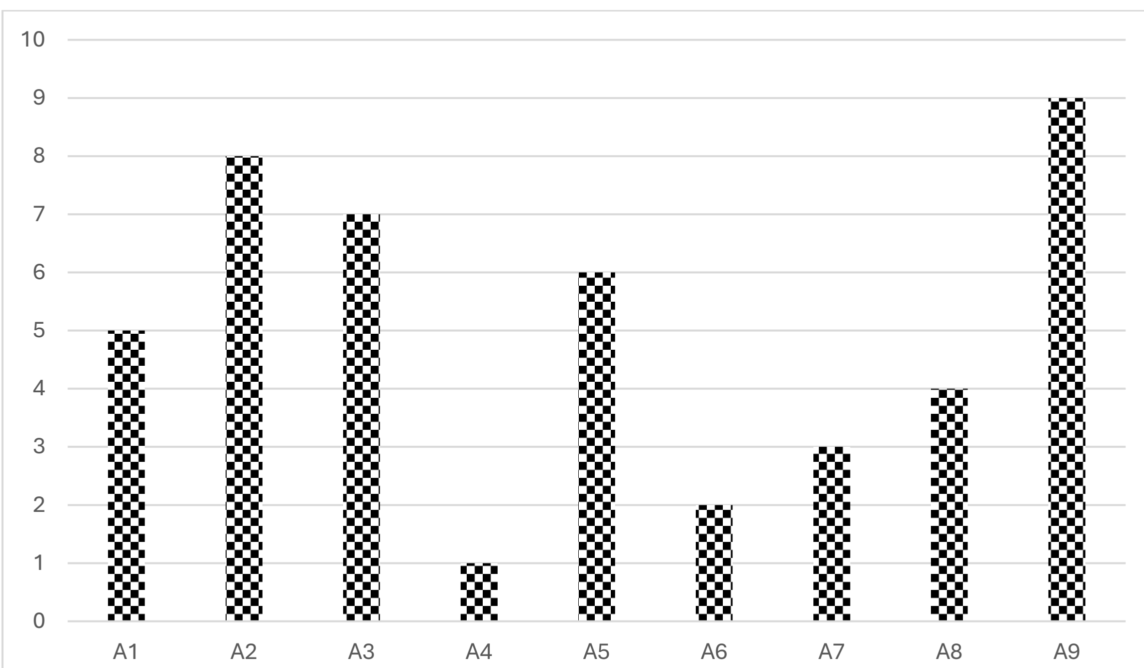

Fig 7. The ranks of the alternatives.

Third criterion

We established the evaluating matrix. Three experts evaluate the criteria and alternatives using a scale between 0.1 to 0.9. This criterion has three sub-criteria as shown in Fig 8.

We obtained the overall evaluation matrix using the average method.

We standardized the overall evaluation matrix using Eq. (1) as shown in Table 7.

We determined the overall performance of each alternative using Eq. (2).

Then we calculate the performance of the program after deleting each criterion using Eq. (3).

Then we assessed the combined of deviations from absolute values using Eq. (4).

Then we computed the criteria weights using Eq. (5) as shown in Fig 9.

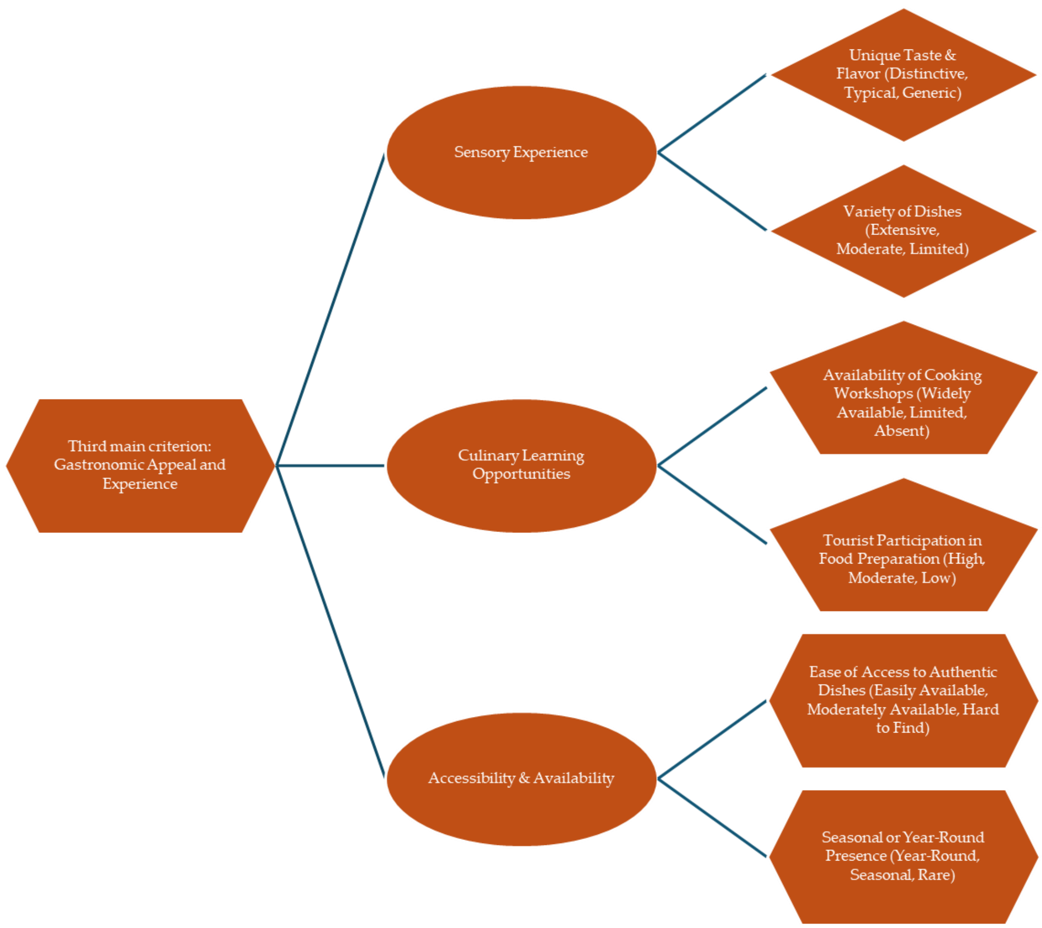

Fig 8. Classification of third criterion.

Table 7. Scandalized matrix.

	C_{3111}	C_{3121}	C_{3211}	C_{3221}	C_{3311}	C_{3321}
A_1	1.044016	1.550187	1.241755	1	1.131098	1
A_2	1.115904	1	1.604524	1.262197	1.131098	1.262197
A_3	1	1.291721	1	1.131098	1.131098	1.131098
A_4	1.346908	1.112605	1.393295	1.261743	1.262197	1.392841
A_5	1.435341	1.840898	1	1.573726	1.261743	1.442627
A_6	1.400321	1.515112	1.785228	1.382393	1.70437	1.644136
A_7	1.471807	1.852219	1.542655	1.594349	1.563278	1.382393
A_8	1.114458	1.60558	1.604524	1.523213	1.483601	1.362678
A_9	1.418554	1.852219	1.543836	1.403016	1	1.131098

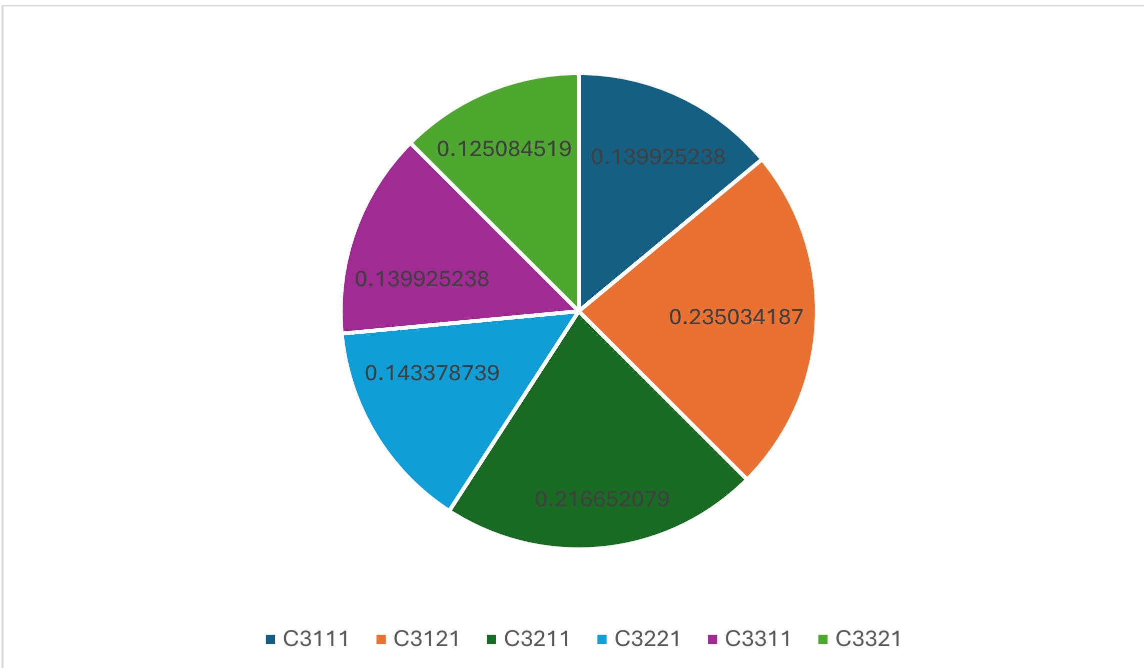

Fig 9. Weights of the third criterion.

We applied the MARCOS method to obtain Standardize the decision matrix using Eq. (6) as shown in Table 8.

Then we formed the weighted standardized decision matrix using Eq. (8) as shown in Table 9.

Then we calculated the utility digress of alternatives using Eqs. (9-11).

Then we computed the utility function using Eqs. (12-14). Then we ranked the alternatives in Fig 10.

Table 8. Scandalized matrix by MARCOS.

	C_{3111}	C_{3121}	C_{3211}	C_{3221}	C_{3311}	C_{3321}

A_1	0.709343	0.836935	0.695573	0.627215	1.506827	0.608222
A_2	0.758186	0.539893	0.898779	0.791669	1.506827	0.767696
A_3	0.679437	0.697391	0.560153	0.709442	1.506827	0.687959
A_4	0.915139	0.600688	0.780458	0.791384	1.35032	0.847157
A_5	0.975224	0.993888	0.560153	0.987065	1.350806	0.877438
A_6	0.95143	0.817998	1	0.867058	1	1
A_7	1	1	0.864122	1	1.090254	0.840802
A_8	0.757204	0.866841	0.898779	0.955382	1.148806	0.828811
A_9	0.963818	1	0.864784	0.879993	1.70437	0.687959

Table 9. Weighted scandalized matrix.

	C_{3111}	C_{3121}	C_{3211}	C_{3221}	C_{3311}	C_{3321}
A_1	0.099255	0.196708	0.150697	0.089929	0.210843	0.076079
A_2	0.106089	0.126893	0.194722	0.113509	0.210843	0.096027
A_3	0.09507	0.163911	0.121358	0.101719	0.210843	0.086053
A_4	0.128051	0.141182	0.169088	0.113468	0.188944	0.105966
A_5	0.136458	0.233598	0.121358	0.141524	0.189012	0.109754
A_6	0.133129	0.192258	0.216652	0.124318	0.139925	0.125085
A_7	0.139925	0.235034	0.187214	0.143379	0.152554	0.105171
A_8	0.105952	0.203737	0.194722	0.136981	0.160747	0.103671
A_9	0.134862	0.235034	0.187357	0.126172	0.238484	0.086053

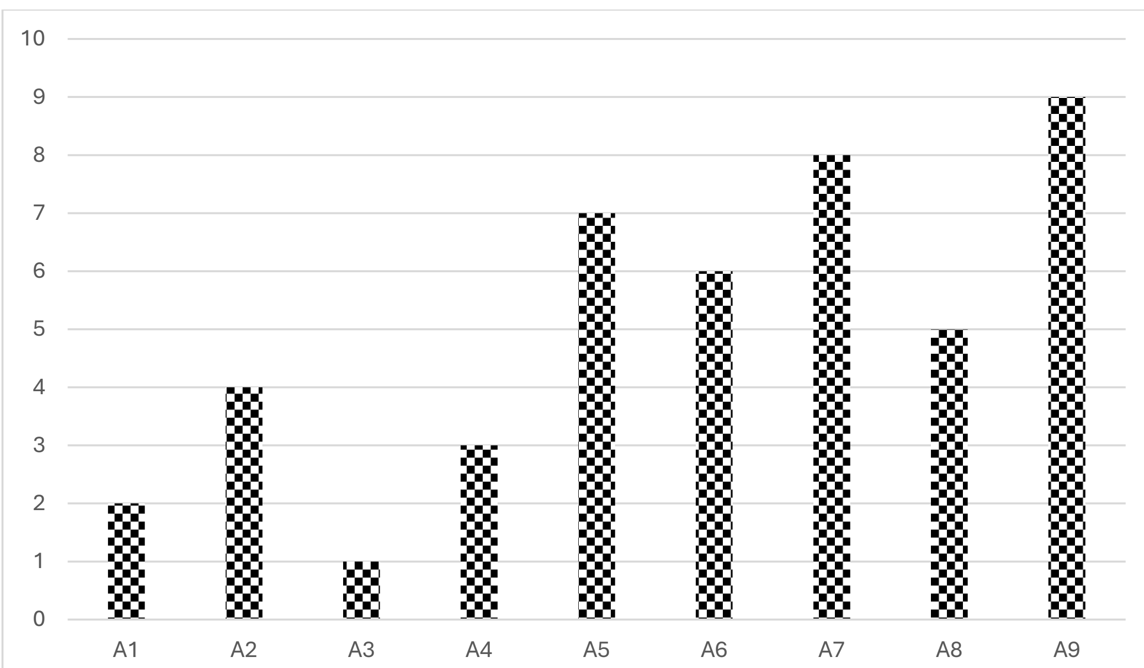

Fig 10. The ranks of the alternatives.

Fourth criterion

We established the evaluating matrix. Three experts evaluate the criteria and alternatives using a scale between 0.1 to 0.9. This criterion has three sub-criteria as shown in Fig 11.

We obtained the overall evaluation matrix using the average method.

We standardized the overall evaluation matrix using Eq. (1) as shown in Table 10.

We determined the overall performance of each alternative using Eq. (2).

Then we calculate the performance of the program after deleting each criterion using Eq. (3).

Then we assessed the combined of deviations from absolute values using Eq. (4).

Then we computed the criteria weights using Eq. (5) as shown in Fig 12.

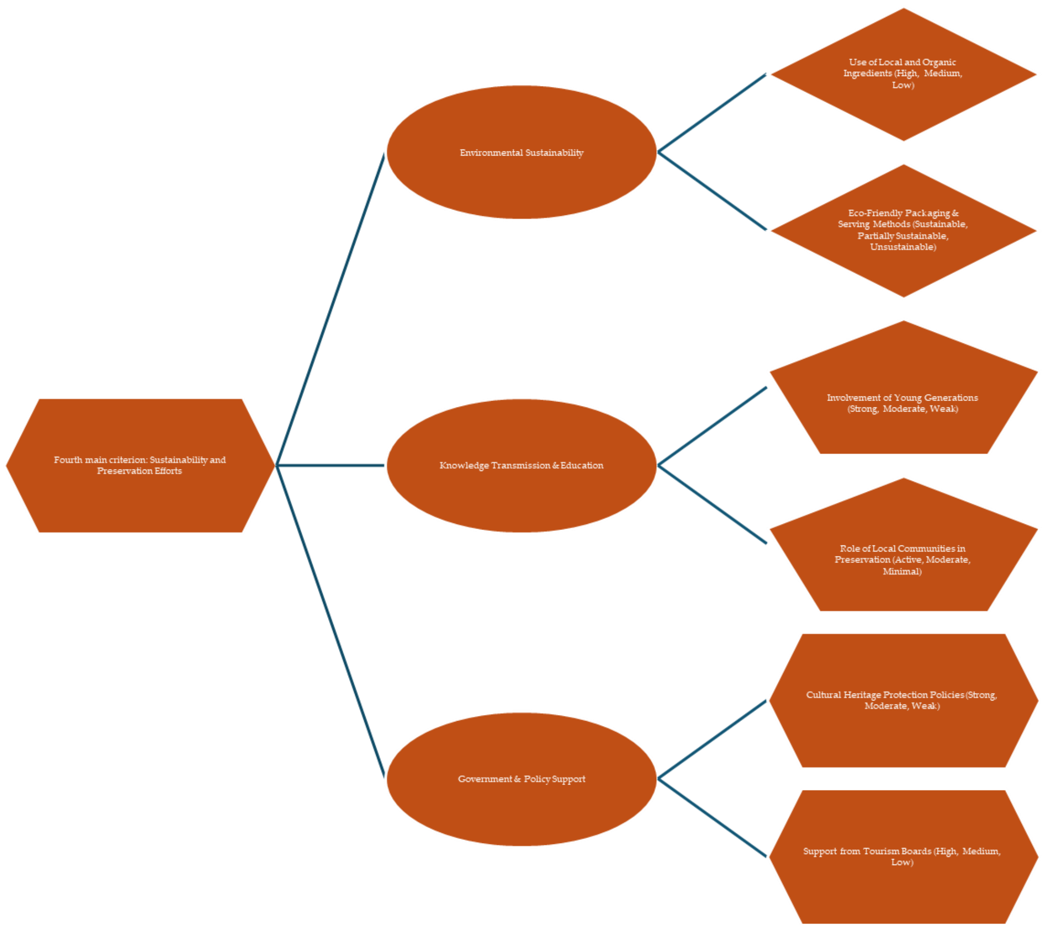

Fig 11. Classification of fourth criterion.

Table 10. Scandalized matrix.

	C_{4111}	C_{4121}	C_{4211}	C_{4221}	C_{4311}	C_{4321}
A_1	1.329575	1.199906	1.070237	1.016978	1.046746	1.180885

A_2	1.347349	1.085596	1.347349	1.242782	1.260215	1.392568
A_3	1.365124	1.328535	1.329575	1.346295	1.334791	1.382393
A_4	1.329575	1.364056	1.365124	1.328535	1.465781	1.563278
A_5	1.035549	1.346295	1.347349	1.208278	1.427611	1.1003
A_6	1.156683	1.016978	1.017775	1.242156	1.111905	1.392568
A_7	1.261139	1	1.000783	1.016978	1.241971	1
A_8	1	1.156404	1	1	1.074575	1.241755
A_9	1.382899	1.260152	1.330593	1.260152	1	1.131098

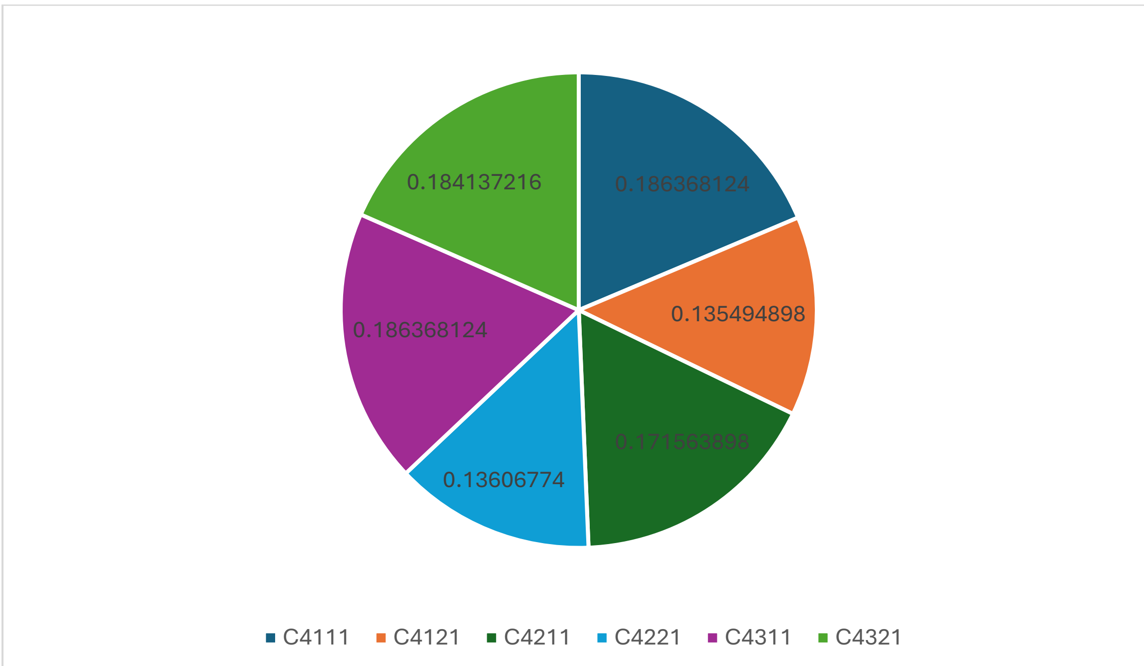

Fig 12. Weights of the fourth criterion.

We applied the MARCOS method to obtain Standardize the decision matrix using Eq. (6) as shown in Table 11.

Then we formed the weighted standardized decision matrix using Eq. (8) as shown in Table 12.

Then we calculated the utility digress of alternatives using Eqs. (9-11).

Then we computed the utility function using Eqs. (12-14). Then we ranked the alternatives in Fig 13.

Table 11. Scandalized matrix by MARCOS.

	C_{4111}	C_{4121}	C_{4211}	C_{4221}	C_{4311}	C_{4321}
A_1	0.96144	0.87966	0.783985	0.75539	1.400321	0.75539
A_2	0.974294	0.795859	0.986979	0.923113	1.16312	0.8908

A_3	0.987147	0.973959	0.973959	1	1.098136	0.884291
A_4	0.96144	1	1	0.986808	1	1
A_5	0.748825	0.986979	0.986979	0.897484	1.026737	0.703841
A_6	0.836419	0.745555	0.745555	0.922648	1.318261	0.8908
A_7	0.911953	0.733108	0.733108	0.75539	1.180206	0.639682
A_8	0.723119	0.847769	0.732534	0.742779	1.364056	0.794328
A_9	1	0.923827	0.974705	0.936014	1.465781	0.723543

Table 12. Weighted scandalized matrix.

	C_{4111}	C_{4121}	C_{4211}	C_{4221}	C_{4311}	C_{4321}
A_1	0.179182	0.11919	0.134504	0.102784	0.260975	0.139095
A_2	0.181577	0.107835	0.16933	0.125606	0.216768	0.164029
A_3	0.183973	0.131966	0.167096	0.136068	0.204657	0.162831
A_4	0.179182	0.135495	0.171564	0.134273	0.186368	0.184137
A_5	0.139557	0.133731	0.16933	0.122119	0.191351	0.129603
A_6	0.155882	0.101019	0.12791	0.125543	0.245682	0.164029
A_7	0.169959	0.099332	0.125775	0.102784	0.219953	0.117789
A_8	0.134766	0.114868	0.125676	0.101068	0.254217	0.146265
A_9	0.186368	0.125174	0.167224	0.127361	0.273175	0.133231

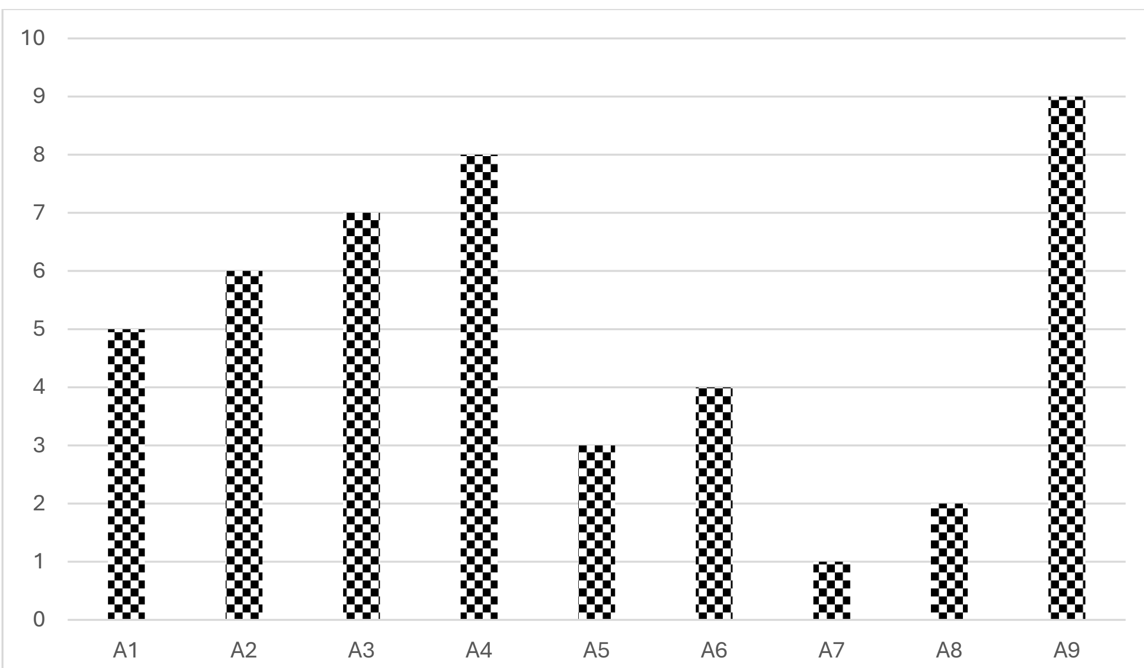

Fig 13. The ranks of the alternatives.

4. Conclusions

The evaluation of culinary intangible cultural heritage tourism resources is a necessary step in preserving and promoting the diversity of global food traditions. A structured, multi-criteria framework ensures that key aspects such as cultural authenticity, economic impact, gastronomic appeal, sustainability, and policy support are carefully analyzed. By leveraging advanced decision-making techniques, stakeholders can make informed decisions on how best to enhance, protect, and market culinary heritage for future generations. We used the Forest HyperSoft set to divide each criterion in main criteria as a TreeSoft set. In each TreeSoft set, we can compute the criteria weights by the MEREC method and ranking the alternatives.

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Received: Oct 19, 2024. Accepted: March 22, 2025