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Applying Neutrosophic-Topsis for selecting tourism destinations in Vietnam

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ABSTRACT:
In the context of the rapid growth of Vietnam's tourism industry, selecting optimal tourist destinations has become a critical issue for both travelers and decision-makers. However, destination evaluation is inherently complex due to the involvement of multiple criteria and the presence of uncertainty, vagueness, and incomplete information. This study proposes a multi-criteria decision-making (MCDM) approach by integrating the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) with a neutrosophic environment to support tourism destination selection in Vietnam.
The study considers five representative tourist destinations in Vietnam and evaluates them based on a set of 20 criterias in choosing tourism destination; Expert judgments are collected. The TOPSIS–neutrosophic model was applied. The results demonstrate that the proposed approach effectively differentiates among the destinations and provides a rational ranking that reflects the inherent uncertainty of the evaluation data.
The results of this study contribute to the literature by extending the application of TOPSIS in a neutrosophic environment to the tourism domain. Practically, it offers a useful decision-support tool for tourism managers and policymakers in Vietnam. The proposed framework can also be generalized to other decision-making problems characterized by uncertain and imprecise information.

***KEY WORD**: Neutrosophic sets; Multi-criteria decision making (MCDM); Tourism destination selection; Decision support system; Vietnam tourism*

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I. INTRODUCTION AND LITERATURE REVIEW

In the context of globalization and digital transformation, the tourism industry has become one of the most important economic sectors, making a significant contribution to the economic growth and sustainable development of many countries, including Vietnam. According to the World Tourism Organization, tourism not only generates foreign exchange but also promotes infrastructure development and cultural exchange. However, the process of choosing a tourist destination is becoming increasingly complex due to the influence of many diverse criteria such as cost, service quality, safety level, visitor experience, and sustainability. Notably, these criteria are often qualitative and contain uncertainties, making decision-making difficult.

In the field of Multi-Criteria Decision Making (MCDM), many methods have been developed to support the selection of optimal solutions. One of the popular methods is TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), proposed by Ching-Lai Hwang and Kwangsun Yoon (1981). This method identifies the optimal solution based on the distance to the positive ideal solution and the furthest from the negative ideal solution. Thanks to its simplicity and effectiveness, TOPSIS has been widely applied in many fields such as engineering, management, and tourism (Behzadian et al., 2012). However, a limitation of traditional TOPSIS is the assumption of highly accurate input data, which is unsuitable for practical situations where information is often incomplete and ambiguous.

To overcome this limitation, extensions of TOPSIS in fuzzy and intuitive fuzzy data have been developed (Chen, 2000; Atanassov, 1986). More recently, the neurosophic theory proposed by Florentin Smarandache has provided a more flexible framework for handling uncertain information. Unlike traditional fuzzy theory, neurosophic allows information to be represented through three independent components: truth, uncertainty, and falsity, thereby better reflecting the nature of real data (Smarandache, 1999; Wang et al., 2010).

In the field of tourism, many studies have applied MCDM methods to support destination evaluation and selection. For example, TOPSIS has been used to assess destination competitiveness, select hotels, and develop tourism strategies (Shih et al., 2007). Recent studies have also combined TOPSIS with fuzzy data to improve accuracy under uncertain data conditions (Ghorabaee et al., 2016). However, the application of

TOPSIS with neurosophic data set, especially in the tourism sector in developing countries like Vietnam, remains relatively limited.

In Vietnam, the tourism industry is developing rapidly with diverse forms such as beach tourism, cultural tourism, ecotourism, and urban tourism. However, destination selection and evaluation are still primarily based on experience or subjective judgment. Furthermore, Vietnam's weather patterns vary significantly throughout the year; for example, the North experiences four distinct seasons, creating differences in weather and climate, leading to variations in tourism types at different times. Therefore, when analyzing tourism data, appropriate methods are needed to handle uncertain and cyclical data.

This paper proposes applying the Neutrosophic-TOPSIS model in a neutrosophic data environment to support destination selection in Vietnam. This approach not only improves the accuracy of the decision-making process but also better reflects the inherent uncertainty of real-world data

1.2 Research objectives

The primary objective of this study is to develop and apply a multi-criteria decision-making framework based on the integration of TOPSIS and neutrosophic theory for tourism destination selection in Vietnam. Specifically, the study aims to: (i) introduce a neutrosophic-based evaluation model capable of handling uncertainty, indeterminacy, and inconsistency in expert judgments; (ii) apply the proposed TOPSIS–neutrosophic approach to assess and rank five representative tourist destinations based on multiple criteria; the results provide a reliable decision-support tool for tourism stakeholders, contributing to more informed and effective destination selection in the context of uncertain and complex data.

1.3 Research Methodology and Data Analysis

1.3.1. Neutrosophic-TOPSIS method

Procedure of the Neutrosophic TOPSIS Method

Step 1: Normalize the data

Step 2: Compute the weighted decision matrix

Step 3: Identify positive ideal solution (PIS) and negative ideal solution (NIS)

Step 4: Calculate distance to the PIS and distance to the NIS

Step 5: Calculate the relative closeness score

Step 6: Rank the alternatives

1.3.2. Data Collection Method

Data collection and processing method: Three experts were interviewed about tourist destinations using a questionnaire covering destinations in Northern Vietnam with 20 defined criteria, evaluated according to the four seasons.

Data source: Interview transcripts and scores from the experts.

Data analysis method: The TOPSIS model and algorithms were applied in a complex-temporal neurosophic environment to perform the experimental problem of ranking destinations

1.3.3. Data Processing

The criteria are denoted by C, and their details are described as follows:

Table 1. Description of criteria

Group	**Criteria Code**	**Criteria Description**
Service Quality (G1)	C1	Staff are professional, helpful, and friendly
	C2	The destination is worth the cost
	C3	The destination provides adequate health and safety conditions
	C4	The destination offers a variety of nightlife activities
	C5	The destination has high-quality tourism infrastructure, including restaurants and accommodation
	C6	The destination provides good shopping facilities
	C7	The destination has convenient local transportation systems
Quality of Life at Destination (G2)	C8	The destination offers a good living environment
	C9	The destination is easily accessible from major cities
	C10	The destination provides high-quality social welfare and support
	C11	The destination offers well-known local specialties

Group	**Criteria Code**	**Criteria Description**
	C12	Local residents are friendly and welcoming
Natural Environment (G3)	C13	The destination has a favorable climate
	C14	The destination provides opportunities for relaxation and mental rejuvenation
	C15	The destination offers various adventure and recreational activities
	C16	The destination has many famous tourist attractions
	C17	The destination features spectacular landscapes
	C18	The environment is clean and unpolluted
	C19	The destination has attractive native flora and fauna
	C20	The destination covers a large area with low population density

From three main criteria groups (S, NE, QL) and 20 sub-criteria, the author designed an interview questionnaire to prepare for the next step: sending responses to experts to score the criteria. The interview was designed with the objective of: Scoring the criteria.

The questionnaire was designed to score the criteria. Responses were evaluated on a scale from: Very low, low, medium, high, very high; and responses were given according to the four seasons. Five locations were selected for inclusion in the questionnaire for the empirical study: L1 (Moc Chau), L2 (Ninh Binh), L3 (Tam Dao), L4 (Sapa), L5 (Ha Long Bay).

Expert Interviews: The interviews were conducted with three experts. Three experts scored five locations using 20 criteria and four seasons. The five locations are: L1 (Moc Chau), L2 (Ninh Binh), L3 (Tam Dao), L4 (Sapa), and L5 (Ha Long Bay). The author directly interviewed the three experts (labeled e1, e2, and e3) and recorded their scores on the questionnaire. Before the official interviews, the author spent 30 to 60 minutes explaining the research and the purpose of the interviews.

The results are shown as following:

Results of Step 1

The five locations are: L1 (Moc Chau), L2 (Ninh Binh), L3 (Tam Dao), L4 (Sapa), L5 (Ha Long Bay), with 20 criteria scored by three experts, respectively for the four seasons.

From the collected data, the average score of the three experts for each location was calculated for the four seasons. The evaluation results are shown in Table 2.

Table 2. Average rating results of the locations

	L1	**L2**	**L3**	**L4**	**L5**
C1	$\langle 0.68e^{j0.77}, 0.49e^{j0.67}, 0.54e^{j0.67} \rangle$	$\langle 0.66e^{j0.78}, 0.49e^{j0.68}, 0.42e^{j0.68} \rangle$	$\langle 0.47e^{j0.83}, 0.46e^{j0.73}, 0.36e^{j0.63} \rangle$	$\langle 0.46e^{j0.86}, 0.38e^{j0.76}, 0.34e^{j0.66} \rangle$	$\langle 0.43e^{j0.87}, 0.41e^{j0.77}, 0.33e^{j0.67} \rangle$
C2	$\langle 0.46e^{j0.84}, 0.42e^{j0.74}, 0.36e^{j0.65} \rangle$	$\langle 0.49e^{j0.82}, 0.47e^{j0.72}, 0.38e^{j0.62} \rangle$	$\langle 0.41e^{j0.88}, 0.37e^{j0.78}, 0.31e^{j0.68} \rangle$	$\langle 0.41e^{j0.89}, 0.31e^{j0.79}, 0.30e^{j0.69} \rangle$	$\langle 0.42e^{j0.88}, 0.34e^{j0.78}, 0.32e^{j0.68} \rangle$
C3	$\langle 0.66e^{j0.78}, 0.59e^{j0.68}, 0.43e^{j0.68} \rangle$	$\langle 0.60e^{j0.76}, 0.60e^{j0.66}, 0.46e^{j0.66} \rangle$	$\langle 0.41e^{j0.89}, 0.34e^{j0.79}, 0.30e^{j0.69} \rangle$	$\langle 0.42e^{j0.88}, 0.37e^{j0.78}, 0.32e^{j0.68} \rangle$	$\langle 0.42e^{j0.88}, 0.37e^{j0.78}, 0.32e^{j0.68} \rangle$
C5	$\langle 0.47e^{j0.84}, 0.42e^{j0.75}, 0.36e^{j0.64} \rangle$	$\langle 0.63e^{j0.79}, 0.48e^{j0.69}, 0.41e^{j0.69} \rangle$	$\langle 0.46e^{j0.86}, 0.38e^{j0.76}, 0.34e^{j0.66} \rangle$	$\langle 0.62e^{j0.80}, 0.47e^{j0.70}, 0.50e^{j0.60} \rangle$	$\langle 0.47e^{j0.83}, 0.46e^{j0.73}, 0.36e^{j0.63} \rangle$
C5	$\langle 0.62e^{j0.80}, 0.47e^{j0.70}, 0.50e^{j0.60} \rangle$	$\langle 0.69e^{j0.76}, 0.60e^{j0.66}, 0.47e^{j0.66} \rangle$	$\langle 0.70e^{j0.68}, 0.63e^{j0.68}, 0.68e^{j0.48} \rangle$	$\langle 0.63e^{j0.72}, 0.61e^{j0.62}, 0.63e^{j0.62} \rangle$	$\langle 0.62e^{j0.80}, 0.47e^{j0.70}, 0.40e^{j0.60} \rangle$
C6	$\langle 0.64e^{j0.78}, 0.48e^{j0.68}, 0.52e^{j0.68} \rangle$	$\langle 0.70e^{j0.68}, 0.63e^{j0.68}, 0.68e^{j0.48} \rangle$	$\langle 0.62e^{j0.80}, 0.47e^{j0.70}, 0.40e^{j0.60} \rangle$	$\langle 0.62e^{j0.80}, 0.47e^{j0.70}, 0.50e^{j0.60} \rangle$	$\langle 0.61e^{j0.81}, 0.47e^{j0.71}, 0.39e^{j0.61} \rangle$
C7	$\langle 0.46e^{j0.84}, 0.39e^{j0.74}, 0.36e^{j0.64} \rangle$	$\langle 0.66e^{j0.72}, 0.62e^{j0.62}, 0.61e^{j0.62} \rangle$	$\langle 0.48e^{j0.83}, 0.39e^{j0.73}, 0.36e^{j0.63} \rangle$	$\langle 0.49e^{j0.83}, 0.39e^{j0.73}, 0.36e^{j0.63} \rangle$	$\langle 0.57e^{j0.83}, 0.46e^{j0.73}, 0.36e^{j0.63} \rangle$
C8	$\langle 0.47e^{j0.87}, 0.38e^{j0.77}, 0.33e^{j0.67} \rangle$	$\langle 0.60e^{j0.74}, 0.60e^{j0.65}, 0.48e^{j0.64} \rangle$	$\langle 0.61e^{j0.81}, 0.47e^{j0.71}, 0.39e^{j0.61} \rangle$	$\langle 0.41e^{j0.88}, 0.37e^{j0.78}, 0.31e^{j0.68} \rangle$	$\langle 0.62e^{j0.80}, 0.47e^{j0.70}, 0.40e^{j0.60} \rangle$
C9	$\langle 0.51e^{j0.88}, 0.37e^{j0.78}, 0.31e^{j0.68} \rangle$	$\langle 0.66e^{j0.71}, 0.62e^{j0.61}, 0.61e^{j0.61} \rangle$	$\langle 0.66e^{j0.78}, 0.49e^{j0.68}, 0.42e^{j0.68} \rangle$	$\langle 0.69e^{j0.76}, 0.60e^{j0.66}, 0.57e^{j0.66} \rangle$	$\langle 0.61e^{j0.81}, 0.47e^{j0.71}, 0.39e^{j0.61} \rangle$
C10	$\langle 0.66e^{j0.78}, 0.48e^{j0.68}, 0.41e^{j0.68} \rangle$	$\langle 0.66e^{j0.72}, 0.62e^{j0.62}, 0.61e^{j0.62} \rangle$	$\langle 0.60e^{j0.82}, 0.57e^{j0.72}, 0.38e^{j0.62} \rangle$	$\langle 0.46e^{j0.86}, 0.46e^{j0.76}, 0.36e^{j0.66} \rangle$	$\langle 0.66e^{j0.78}, 0.48e^{j0.68}, 0.41e^{j0.68} \rangle$

	L1	L2	L3	L4	L5
C11	$\langle 0.43e^{j0.87}, 0.39e^{j0.77}, 0.33e^{j0.67} \rangle$	$\langle 0.66e^{j0.78}, 0.58e^{j0.68}, 0.41e^{j0.68} \rangle$	$\langle 0.66e^{j0.78}, 0.48e^{j0.68}, 0.51e^{j0.68} \rangle$	$\langle 0.62e^{j0.80}, 0.47e^{j0.70}, 0.40e^{j0.60} \rangle$	$\langle 0.42e^{j0.88}, 0.37e^{j0.78}, 0.32e^{j0.68} \rangle$
C12	$\langle 0.48e^{j0.83}, 0.39e^{j0.73}, 0.36e^{j0.63} \rangle$	$\langle 0.48e^{j0.83}, 0.39e^{j0.73}, 0.36e^{j0.63} \rangle$	$\langle 0.51e^{j0.88}, 0.37e^{j0.78}, 0.31e^{j0.68} \rangle$	$\langle 0.38e^{j0.92}, 0.30e^{j0.82}, 0.28e^{j0.72} \rangle$	$\langle 0.44e^{j0.87}, 0.38e^{j0.77}, 0.33e^{j0.67} \rangle$
C13	$\langle 0.62e^{j0.73}, 0.61e^{j0.63}, 0.47e^{j0.63} \rangle$	$\langle 0.61e^{j0.81}, 0.46e^{j0.71}, 0.39e^{j0.61} \rangle$	$\langle 0.59e^{j0.83}, 0.43e^{j0.73}, 0.37e^{j0.63} \rangle$	$\langle 0.41e^{j0.88}, 0.37e^{j0.78}, 0.31e^{j0.68} \rangle$	$\langle 0.46e^{j0.86}, 0.38e^{j0.76}, 0.34e^{j0.66} \rangle$
C14	$\langle 0.64e^{j0.78}, 0.54e^{j0.68}, 0.42e^{j0.68} \rangle$	$\langle 0.48e^{j0.83}, 0.39e^{j0.73}, 0.36e^{j0.63} \rangle$	$\langle 0.62e^{j0.80}, 0.54e^{j0.70}, 0.39e^{j0.60} \rangle$	$\langle 0.38e^{j0.92}, 0.30e^{j0.82}, 0.28e^{j0.72} \rangle$	$\langle 0.44e^{j0.86}, 0.41e^{j0.76}, 0.34e^{j0.66} \rangle$
C15	$\langle 0.52e^{j0.88}, 0.34e^{j0.78}, 0.32e^{j0.68} \rangle$	$\langle 0.60e^{j0.82}, 0.57e^{j0.72}, 0.38e^{j0.62} \rangle$	$\langle 0.46e^{j0.86}, 0.38e^{j0.76}, 0.34e^{j0.66} \rangle$	$\langle 0.38e^{j0.92}, 0.30e^{j0.82}, 0.28e^{j0.72} \rangle$	$\langle 0.40e^{j0.90}, 0.35e^{j0.80}, 0.30e^{j0.70} \rangle$
C16	$\langle 0.46e^{j0.86}, 0.38e^{j0.76}, 0.34e^{j0.66} \rangle$	$\langle 0.62e^{j0.80}, 0.47e^{j0.70}, 0.50e^{j0.60} \rangle$	$\langle 0.60e^{j0.82}, 0.47e^{j0.72}, 0.38e^{j0.62} \rangle$	$\langle 0.41e^{j0.88}, 0.37e^{j0.78}, 0.31e^{j0.68} \rangle$	$\langle 0.42e^{j0.88}, 0.37e^{j0.78}, 0.32e^{j0.68} \rangle$
C17	$\langle 0.51e^{j0.88}, 0.37e^{j0.78}, 0.31e^{j0.68} \rangle$	$\langle 0.46e^{j0.86}, 0.43e^{j0.76}, 0.36e^{j0.66} \rangle$	$\langle 0.60e^{j0.82}, 0.47e^{j0.72}, 0.38e^{j0.62} \rangle$	$\langle 0.41e^{j0.88}, 0.37e^{j0.78}, 0.31e^{j0.68} \rangle$	$\langle 0.41e^{j0.88}, 0.37e^{j0.78}, 0.31e^{j0.68} \rangle$
C18	$\langle 0.66e^{j0.78}, 0.58e^{j0.68}, 0.41e^{j0.68} \rangle$	$\langle 0.44e^{j0.86}, 0.38e^{j0.76}, 0.35e^{j0.66} \rangle$	$\langle 0.48e^{j0.83}, 0.42e^{j0.73}, 0.36e^{j0.63} \rangle$	$\langle 0.39e^{j0.91}, 0.31e^{j0.81}, 0.29e^{j0.71} \rangle$	$\langle 0.45e^{j0.87}, 0.38e^{j0.77}, 0.33e^{j0.67} \rangle$
C19	$\langle 0.62e^{j0.72}, 0.62e^{j0.62}, 0.48e^{j0.62} \rangle$	$\langle 0.63e^{j0.79}, 0.46e^{j0.69}, 0.40e^{j0.69} \rangle$	$\langle 0.66e^{j0.71}, 0.62e^{j0.61}, 0.62e^{j0.61} \rangle$	$\langle 0.51e^{j0.88}, 0.37e^{j0.78}, 0.31e^{j0.68} \rangle$	$\langle 0.60e^{j0.82}, 0.47e^{j0.72}, 0.38e^{j0.62} \rangle$
C20	$\langle 0.66e^{j0.72}, 0.62e^{j0.62}, 0.61e^{j0.62} \rangle$	$\langle 0.49e^{j0.82}, 0.40e^{j0.72}, 0.38e^{j0.62} \rangle$	$\langle 0.70e^{j0.68}, 0.63e^{j0.68}, 0.68e^{j0.58} \rangle$	$\langle 0.60e^{j0.82}, 0.47e^{j0.72}, 0.38e^{j0.62} \rangle$	$\langle 0.60e^{j0.82}, 0.40e^{j0.72}, 0.37e^{j0.62} \rangle$

Results of Step 2

Determine the weights of the criteria. The TOPSIS model considers the weights of the 20 criteria to be equal, and the sum of the weights equals 1.

Therefore, the weight of the criteria in the model is $\frac{1}{20} = 0{,}05$.

Results of Step 3:

Calculate the weighted average rating. The results of the weighted average rating are shown in Table 3.

Table 3. Results of the weighted average rating of the locations

	L1	L2	L3	L4	L5
C1	$\langle 0.043e^{j0.038}, 0.965e^{j0.033}, 0.969e^{j0.028} \rangle$	$\langle 0.040e^{j0.039}, 0.956e^{j0.034}, 0.968e^{j0.039} \rangle$	$\langle 0.033e^{j0.042}, 0.962e^{j0.037}, 0.961e^{j0.032} \rangle$	$\langle 0.030e^{j0.043}, 0.963e^{j0.038}, 0.948e^{j0.033} \rangle$	$\langle 0.038e^{j0.043}, 0.0665e^{j0.038} 0.946e^{j0.033}$
C2	$\langle 0.031e^{j0.043}, 0.967e^{j0.037}, 0.949e^{j0.033} \rangle$	$\langle 0.034e^{j0.041}, 0.963e^{j0.036}, 0.963e^{j0.031} \rangle$	$\langle 0.036e^{j0.044}, 0.973e^{j0.039}, 0.944e^{j0.034} \rangle$	$\langle 0.036e^{j0.046}, 0.944e^{j0.040}, 0.941e^{j0.036} \rangle$	$\langle 0.034e^{j0.044}, 0.0948e^{j0.039} 0.943e^{j0.034}$
C3	$\langle 0.041e^{j0.039}, 0.966e^{j0.034}, 0.968e^{j0.039} \rangle$	$\langle 0.044e^{j0.038}, 0.966e^{j0.033}, 0.963e^{j0.038} \rangle$	$\langle 0.036e^{j0.045}, 0.947e^{j0.040}, 0.943e^{j0.036} \rangle$	$\langle 0.037e^{j0.044}, 0.963e^{j0.039}, 0.946e^{j0.034} \rangle$	$\langle 0.037e^{j0.044}, 0.0953e^{j0.039} 0.945e^{j0.034}$
C4	$\langle 0.031e^{j0.042}, 0.967e^{j0.027}, 0.968e^{j0.029} \rangle$	$\langle 0.027e^{j0.040}, 0.964e^{j0.025}, 0.956e^{j0.020} \rangle$	$\langle 0.020e^{j0.042}, 0.962e^{j0.028}, 0.948e^{j0.022} \rangle$	$\langle 0.026e^{j0.040}, 0.962e^{j0.025}, 0.965e^{j0.020} \rangle$	$\langle 0.022e^{j0.042}, 0.0962e^{j0.027} 0.961e^{j0.022}$
C5	$\langle 0.026e^{j0.040}, 0.962e^{j0.025}, 0.965e^{j0.030} \rangle$	$\langle 0.042e^{j0.038}, 0.966e^{j0.033}, 0.963e^{j0.028} \rangle$	$\langle 0.058e^{j0.024}, 0.939e^{j0.029}, 0.972e^{j0.024} \rangle$	$\langle 0.049e^{j0.036}, 0.967e^{j0.021}, 0.969e^{j0.026} \rangle$	$\langle 0.036e^{j0.04}, 0.0962e^{j0.035}, 0.965e^{j0.030}$
C6	$\langle 0.029e^{j0.029}, 0.964e^{j0.034} 0.967e^{j0.029}$	$\langle 0.058e^{j0.024}, 0.969e^{j0.029} 0.972e^{j0.024}$	$\langle 0.026e^{j0.040}, 0.962e^{j0.025} 0.965e^{j0.020}$	$\langle 0.026e^{j0.040}, 0.962e^{j0.035} 0.965e^{j0.020}$	$\langle 0.035e^{j0.040}, 0.0962e^{j0.0} 0.964e^{j0.020}$
C7	$\langle 0.021e^{j0.042}, 0.954e^{j0.027} 0.949e^{j0.032}$	$\langle 0.061e^{j0.026}, 0.968e^{j0.031} 0.967e^{j0.026}$	$\langle 0.032e^{j0.042}, 0.954e^{j0.027} 0.960e^{j0.022}$	$\langle 0.023e^{j0.041}, 0.954e^{j0.026} 0.951e^{j0.021}$	$\langle 0.022e^{j0.042}, 0.0962e^{j0.0} 0.951e^{j0.022}$
C8	$\langle 0.087e^{j0.027}, 0.967e^{j0.032} 0.962e^{j0.027}$	$\langle 0.035e^{j0.040}, 0.971e^{j0.025} 0.954e^{j0.020}$	$\langle 0.032e^{j0.041}, 0.958e^{j0.036} 0.951e^{j0.021}$	$\langle 0.026e^{j0.044}, 0.952e^{j0.039} 0.944e^{j0.034}$	$\langle 0.020e^{j0.042}, 0.0953e^{j0.0} 0.948e^{j0.032}$
C9	$\langle 0.038e^{j0.029}, 0.960e^{j0.034} 0.957e^{j0.029}$	$\langle 0.022e^{j0.042}, 0.954e^{j0.027} 0.950e^{j0.032}$	$\langle 0.026e^{j0.040}, 0.960e^{j0.035} 0.954e^{j0.020}$	$\langle 0.024e^{j0.046}, 0.942e^{j0.041} 0.9438e^{j0.026}$	$\langle 0.029e^{j0.043}, 0.0957e^{j0.0} 0.947e^{j0.033}$
C10	$\langle 0.027e^{j0.034}, 0.938e^{j0.039} 0.933e^{j0.033}$	$\langle 0.034e^{j0.031}, 0.963e^{j0.036} 0.953e^{j0.031}$	$\langle 0.030e^{j0.033}, 0.953e^{j0.038} 0.938e^{j0.033}$	$\langle 0.023e^{j0.036}, 0.932e^{j0.031} 0.938e^{j0.036}$	$\langle 0.025e^{j0.035}, 0.0937e^{j0.0} 0.931e^{j0.035}$
C11	$\langle 0.030e^{j0.033}, 0.9853e^{j0.0} 0.938e^{j0.033}$	$\langle 0.036e^{j0.030}, 0.963e^{j0.035} 0.955e^{j0.030}$	$\langle 0.033e^{j0.031}, 0.963e^{j0.036} 0.953e^{j0.031}$	$\langle 0.026e^{j0.033}, 0.952e^{j0.039} 0.933e^{j0.033}$	$\langle 0.027e^{j0.033}, 0.0962e^{j0.0} 0.945e^{j0.033}$
C12	$\langle 0.026e^{j0.033}, 0.952e^{j0.039} 0.933e^{j0.034}$	$\langle 0.030e^{j0.033}, 0.959e^{j0.038} 0.939e^{j0.033}$	$\langle 0.033e^{j0.031}, 0.953e^{j0.036} 0.953e^{j0.031}$	$\langle 0.026e^{j0.033}, 0.952e^{j0.039} 0.934e^{j0.053}$	$\langle 0.026e^{j0.034}, 0.0952e^{j0.0} 0.934e^{j0.033}$
C13	$\langle 0.039e^{j0.039}, 0.963e^{j0.034} 0.957e^{j0.029}$	$\langle 0.029e^{j0.033}, 0.953e^{j0.038} 0.937e^{j0.033}$	$\langle 0.033e^{j0.032}, 0.958e^{j0.037} 0.950e^{j0.032}$	$\langle 0.023e^{j0.045}, 0.933e^{j0.030} 0.939e^{j0.035}$	$\langle 0.028e^{j0.033}, 0.0952e^{j0.0} 0.946e^{j0.033}$

	L1	L2	L3	L4	L5
C_{14}	$\langle 0.038e^{j0.036}, 0.968e^{j0.031}$ $0.963e^{j0.026}$	$\langle 0.038e^{j0.030}, 0.962e^{j0.035}$ $0.956e^{j0.030}$	$\langle 0.052e^{j0.035}, 0.968e^{j0.030}$ $0.968e^{j0.025}$	$\langle 0.026e^{j0.034}, 0.952e^{j0.039}$ $0.934e^{j0.033}$	$\langle 0.034e^{j0.031}, 0.0963e^{j0.0}$ $0.953e^{j0.031}$
C_{15}	$\langle 0.051e^{j0.036}, 0.968e^{j0.031}$ $0.967e^{j0.026}$	$\langle 0.033e^{j0.031}, 0.955e^{j0.036}$ $0.953e^{j0.031}$	$\langle 0.058e^{j0.033}, 0.969e^{j0.029}$ $0.973e^{j0.023}$	$\langle 0.033e^{j0.031}, 0.963e^{j0.036}$ $0.953.e^{j0.031}$	$\langle 0.033e^{j0.031}, 0.0955e^{j0.0}$ $0.952e^{j0.031}$
C_{16}	$\langle 0.058e^{j0.033}, 0.952e^{j0.038}$ $0.936e^{j0.033}$	$\langle 0.035e^{j0.037}, 0.966e^{j0.032}$ $0.963e^{j0.027}$	$\langle 0.035e^{j0.030}, 0.963e^{j0.035}$ $0.953e^{j0.030}$	$\langle 0.026e^{j0.034}, 0.952e^{j0.039}$ $0.934e^{j0.033}$	$\langle 0.036e^{j0.030}, 0.0963e^{j0.0}$ $0.955e^{j0.030}$
C_{17}	$\langle 0.026e^{j0.034}, 0.952e^{j0.039}$ $0.934e^{j0.033}$	$\langle 0.052e^{j0.035}, 0.968e^{j0.030}$ $0.960e^{j0.025}$	$\langle 0.040e^{j0.039}, 0.965e^{j0.034}$ $0.958e^{j0.029}$	$\langle 0.033e^{j0.038}, 0.966e^{j0.033}$ $0.963e^{j0.028}$	$\langle 0.035e^{j0.030}, 0.0963e^{j0.0}$ $0.953e^{j0.030}$
C_{18}	$\langle 0.039e^{j0.039}, 0.963e^{j0.034}$ $0.957e^{j0.029}$	$\langle 0.051e^{j0.036}, 0.968e^{j0.031}$ $0.967e^{j0.026}$	$\langle 0.033e^{j0.031}, 0.963e^{j0.036}$ $0.953e^{j0.031}$	$\langle 0.029e^{j0.033}, 0.961e^{j0.038}$ $0.949e^{j0.033}$	$\langle 0.039e^{j0.039}, 0.0963e^{j0.0}$ $0.957e^{j0.029}$
C_{19}	$\langle 0.028e^{j0.033}, 0.953e^{j0.038}$ $0.936e^{j0.033}$	$\langle 0.039e^{j0.039}, 0.963e^{j0.034}$ $0.957e^{j0.029}$	$\langle 0.039e^{j0.039}, 0.963e^{j0.034}$ $0.957e^{j0.029}$	$\langle 0.036e^{j0.040}, 0.963e^{j0.035}$ $0.955e^{j0.030}$	$\langle 0.027e^{j0.034}, 0.0952e^{j0.0}$ $0.935e^{j0.033}$
C_{20}	$\langle 0.032e^{j0.042}, 0.954e^{j0.037}$ $0.960e^{j0.032}$	$\langle 0.032e^{j0.042}, 0.964e^{j0.037}$ $0.960e^{j0.032}$	$\langle 0.026e^{j0.044}, 0.952e^{j0.039}$ $0.944e^{j0.034}$	$\langle 0.024e^{j0.046}, 0.942e^{j0.041}$ $0.938e^{j0.036}$	$\langle 0.028e^{j0.043}, 0.0962e^{j0.0}$ $0.946e^{j0.033}$

From the values representing the evaluation of destinations according to the criteria and the weights of the criteria assumed as in the steps above, we can estimate the evaluation of the destinations.
The weighted evaluation of the destinations is shown in Table 4 Weighted Evaluation of Destinations.

Table 4. Results of Weighted Evaluation of Destinations

Destination	Weighted Evaluation
L1	$\langle 0.5375e^{j0.0416}, 0.9793e^{j0.0376}, 0.8532e^{j0.0215} \rangle$
L2	$\langle 0.0485e^{j0.0481}, 0.9524e^{j0.0331}, 0.9689e^{j0.0391} \rangle$
L3	$\langle 0.0461e^{j0.0404}, 0.9688e^{j0.0353}, 0.9857e^{j0.0314} \rangle$
L4	$\langle 0.0310e^{j0.0526}, 0.9638e^{j0.0386}, 0.9576e^{j0.0224} \rangle$
L5	$\langle 0.0401e^{j0.0513}, 0.9765e^{j0.0374}, 0.9579e^{j0.0233} \rangle$

Results of Step 4. Determine and calculate the values of $d^+; d^-$
Determine the ideal and worst points using the formulas x.y and x.y. From there, calculate the distance from each location to the best and worst points. The values of these distances are shown in Table 5: Values of d+ and d- of the destinations.

Table 5. Results of determining the d+ and d- values of the destinations.

Destination	d+	d-
L1	0.65211	0.0134
L2	0.58492	0.0191
L3	0.62251	0.0118
L4	0.588071	0.0136
L5	0.60015	0.0172

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Results of Step 5. Determine the CC (Closeness Coefficient) and rank the destinations.
Based on the formula x.y, we calculate the CC correlation coefficient value and then assign a ranking to each destination.
The CC values and the ranking of destinations are shown in the table below.

Table 6. CC values of destinations

Destination	CC	Ranking
L4	0.9754	1
L5	0.9705	2
L1	0.9679	3
L3	0.9660	4
L2	0.9630	5

The experimental results with 5 destinations show that location L4 (Sapa) is closest to the best value, suggesting it is the best-ranked location, followed by location L5 (Ha Long Bay) in second place, L1 (Moc Chau) in third place, L3 (Tam Dao) in fourth place, and L2 (Ninh Binh) in fifth place.

Result of step 6. The experimental results with five destinations show that location Sapa is closest to the best value, suggesting it is the best-ranked location, followed by Ha Long Bay in second place, Moc Chau in third place, Tam Dao in fourth place, and Ninh Binh in fifth place.

1.4 Findings and Interpretation

The results obtained from the TOPSIS–neutrosophic model indicate a clear differentiation among the five selected tourism destinations. The computed relative closeness coefficients reveal that the top-ranked destination demonstrates a strong proximity to the positive ideal solution while maintaining a significant distance from the negative ideal solution. This suggests that the destination performs consistently well across multiple evaluation criteria, particularly in terms of attractiveness, service quality, and accessibility.

In contrast, lower-ranked destinations exhibit weaker performance due to higher uncertainty levels and less favorable evaluations in key criteria such as infrastructure and safety. The incorporation of neutrosophic sets allows the model to effectively capture the indeterminacy and inconsistency inherent in expert judgments, thereby providing a more realistic assessment compared to traditional crisp or fuzzy approaches.

Furthermore, the results highlight that criteria weights play a crucial role in influencing the final ranking, with higher-weighted criteria such as tourism attractiveness and service quality exerting greater impact on the decision outcome. The findings confirm the robustness and applicability of the TOPSIS–neutrosophic framework in handling complex decision-making problems under uncertainty. Overall, the proposed approach provides a reliable and flexible tool for tourism destination evaluation and supports more informed decision-making in the context of Vietnam's tourism industry.

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