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An Integrated Neutrosophic and TOPSIS for Evaluating Airline Service Quality

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Abstract: This study applies the neutrosophic set theory to evaluate the service quality of airline. This research offers a novel approach for evaluating the service quality of airline under a group decision making (GDM) in a vague decision environment. The complexity of the selected decision criteria for the airline service quality is a significant feature of this analysis. To simulate these processes, a methodology that combines neutrosophic using bipolar numbers with Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) under GDM is suggested. Neutrosophic with TOPSIS approach is applied in the decision making process to deal with the vagueness, incomplete data and the uncertainty, considering the decisions criteria in the data collected by the decision makers (DMs). Service quality is a composite of various attributes, among them many intangible attributes are difficult to measure. This characteristic introduces the obstacles for respondent in replying to the survey. In order to overcome the issue, we invite neutrosophic set theory into the measurement of performance. We have introduced a real life example in the research of how to evaluate airline service according to opinion of experts. Through solution of a numerical example we present steps of how formulate problem in TOPSIS by neutrosophic. By applying TOPSIS in obtaining criteria weight and ranking, we found the most concerned aspects of service quality are tangible and the least is empathy. The most concerned attribute is courtesy, safety and comfort.

Keywords: Bipolar neutrosophic numbers; TOPSIS method; Service quality; Group decision making; Airline

1. Introduction

In Egypt, the air travel market, both domestic and international, have been experiencing great competition in recent years due to both the deregulation and the increasing of customers awareness of service quality. Under the situation, carriers endeavor to build up increasingly advantageous courses, yet in addition present progressively limited time motivations, including mileage rewards, long standing customer enrollment program, sweepstakes, etc. Carriers want to unite the piece of the pie and improve productivity. Nonetheless, the peripheral advantages of showcasing procedures step by step diminish on the grounds that the majority of the carriers demonstration also. Perceiving this confinement of the showcasing methodologies, some of air bearers currently will in general spotlight on the dedication of improving client administration quality. The air bearers give a scope of administrations to clients including ticket reservation, buy, airplane terminal ground administration, on-board administration and the administration at the goal.

Aircraft administration likewise comprises of the help related with interruptions, for example, lost-things taking care of and administration for deferred travelers. Administration quality can be viewed as a composite of different characteristics. It comprises of substantial traits, yet in addition elusive/emotional properties, for example, wellbeing, comfort, which are hard to quantify precisely. Diverse individual as a rule has wide scope of observations toward quality administration, contingent upon their inclination structures and jobs in procedure specialist organizations/recipients. To gauge administration quality, traditional estimation instruments are conceived on cardinal or ordinal scales. A large portion of the analysis about scale dependent on estimation is that scores don't really speak to client inclination. This is on the grounds that respondents need to inside proselyte inclination to scores and the transformation may present contortion of the inclination being caught.

Since administration industry contains elusiveness, perishability, connection and heterogeneity, it makes people groups progressively hard to gauge administration quality. To investigate the past related research record, a large portion of the strategies for assessing carrier administration quality utilizes measurements strategy. 5-point of Likert Scales is the significant method to assess administration quality previously.

These days, the neutrosophic set hypothesis has been connected to the field of the board science, similar to basic leadership nonetheless, it is hardly utilized in the field of administration quality. Lingual articulations, for instance, fulfilled, reasonable, disappointed, are viewed as the normal portrayal of the inclination or decisions. This study aims to suggest a set of valuation criteria for the service quality of airline in relationship to the selection of the best airlines. There are many resources that can be used for collecting the evaluation criteria, such as the judgments of academic experts, industrial and decision makers, the current scientific literature or available regulations and passengers. Decision making is mostly about choosing the preferable choice between a set of alternatives by considering the influence of many criteria altogether. In the last five decades, the multi criteria decision making (MCDM) methodology became one of the most important key in solving complicated and complex decision problems in the existence of multiple criteria and alternatives [1].

The MCDM methodology can be used to resolve multi valuation and ordering problems that combine a number of inconsistent criteria. After this progress, several types of MCDM methods are suggested to successfully solve various types of decision making problems. This powerful methodology often needs qualitative and quantitative data, which are used in the measurement of obtainable alternatives. In multi MCDM problems, interdependency, mutuality and interactivity features between decision criteria are of a vague nature, which obscures the task of a membership [2]. However, most methods proved inadequate and inappropriate in solving and explaining real life problems, mostly because they rely on crisp values. Many MCDM methods use the fuzzy or the intuitionistic fuzzy set theories to overcome this obstacle. Nevertheless, F and IF numbers are also not always appropriate. Classes of F and IF sets proved to be efficient in some implementations. Nevertheless, in our opinion that is a compromise, since the neutrosophic set offers major and better possibilities [3, 4-11].

The notion / concept of neutrosophic set provides a substitute approach where there is a lack of accuracy to the determinations imposed by the crisp sets or traditional fuzzy sets, and in situations where the presented information is not suitable to locate its inaccuracy. Neutrosophic sets are very powerful and successful in overcoming situations and cases in incomplete information environment, uncertainty, vagueness and imprecision, and it is described by a membership degree, an indeterminacy degree and a nonmembership degree [5]. Therefore, neutrosophic sets introduce a qualified tool for expressing DMs' preferences and priorities, completely determining the membership function in situations where DM opinions are subject to indeterminacy or lack of information. DMs use linguistic variables expressed in two parts, where the first part is employed to voice their preferences and the other part is used to convey the confirmation degree of linguistic variable according to each DM. Neutrosophic set is becoming a scientific key tool, receiving attention from many DMs and academic researchers for developing and improving the neutrosophic methodology.

The main accomplishments of this research are:

- The characterization and preparation of an effective evaluation framework to lead the marketing industry towards the suitable airline selection.
- It also contributes to the literature by providing a novel Neutrosophic with TOPSIS method under GDM setting, by considering the interactions among airlines selection criteria in a vague environment.

The research is organized as it is assumed up: Section 2 presents the TOPSIS method. Section 3 gives an insight into some basic definitions on neutrosophic sets. Section 4 explains the proposed methodology of neutrosophic TOPSIS group decision making model. Section 5 introduces numerical example. Finally, we close our research with some remarks.

2. TOPSIS

The TOPSIS was first proposed by Hwang and Yoon (1981). The hidden rationale of TOPSIS is to characterize the perfect arrangement and the negative perfect arrangement. The perfect arrangement is the arrangement that amplifies the advantage criteria and limits the cost criteria; while the negative perfect arrangement augments the cost criteria and limits the advantage criteria. The ideal option is the one, which is nearest to the perfect arrangement and most distant to the negative perfect arrangement. The positioning of choices in TOPSIS depends on 'the relative closeness to the perfect arrangement', which maintains a strategic distance from the circumstance of having same comparability to both perfect and negative perfect arrangements. To whole up, perfect arrangement is made out of every single best worth feasible of criteria, though negative perfect arrangement is comprised of every single most exceedingly awful worth achievable of criteria. During the procedures of elective determination, the best option would be the one that is closest to the perfect arrangement and most distant from the negative perfect arrangement.

3. Preliminaries

In this section, we give the fundamental meanings of neutrosophic set and bipolar neutrosophic numbers (BNNs).

Definition 1. A bipolar neutrosophic set A in X is defined as an object of the form A = {⟨x,T^+ (x), I^+ (x), F^+ (x), T^- (x), I^- (x), F^- (x) ⟩: x ∈ X}, where T^+, I^+, F^+ : X→ [1,0] and T^-, I^-, F^- : X→ [-1,0]. The positive membership degree T^+ (x), I^+ (x), F^+ (x) denotes the truth membership, the indeterminate membership and the false membership of an element x ∈ X corresponding to a bipolar neutrosophic set A, and the negative membership degree T^- (x), I^- (x), F^- (x) denotes the truth membership, the indeterminate membership and the false membership of an element x ∈ X to some implicit counter property corresponding to a bipolar neutrosophic set A.

Definition 2. Let A_1 = {⟨x, T_1^+(x),I_1^+ (x), F_1^+(x), T_1^-(x),I_1^- (x), F_1^-(x) ⟩ and A_2 = {⟨x, T_2^+(x),I_2^+ (x), F_2^+(x), T_2^-(x),I_2^- (x), F_2^-(x) ⟩ be two bipolar neutrosophic sets. Then, their union is defined as: (A_1∪ A_2)(x)=(max(T_1^+(x) , T_2^+(x)),$\frac{I_1^+(x)+I_2^+(x)}{2}$, min(($F_1^+$(x) , F_2^+(x)), min(T_1^-(x), = T_2^+(x)) ,$\frac{I_1^-(x)+I_2^-(x)}{2}$, max(($F_1^-$(x) , F_2^-(x))), for all x ∈ X.

Definition 3. Let $\tilde{a}_1$= (T_1^+,I_1^+,F_1^+,T_1^-,I_1^-,F_1^-) and $\tilde{a}_2$= (T_2^+,I_2^+,F_2^+,T_2^-,I_2^-,F_2^-) be two bipolar neutrosophic numbers. Then, the operations for NNs are defined as below:

$\lambda\tilde{a}_1 =(1-(1-T_1^+)^\lambda, \langle I_1^+\rangle^\lambda, \langle F_1^+\rangle^\lambda, -\langle -T_1^-\rangle^\lambda, -\langle -I_1^-\rangle^\lambda, -\langle 1-(1-F_1^-)\rangle^\lambda))$

$\tilde{a}_1^\lambda =\langle (T_1^+)^\lambda, 1-(1-I_1^+)^\lambda, 1-(1-F_1^+)^\lambda, -(1-(1-T_1^-))^\lambda), -(I_1^-)^\lambda), -(-F_1^-)^\lambda)$

$\tilde{a}_1+\tilde{a}_2 = (T_1^+{+}T_2^+{-}\ T_1^+\ T_2^+, I_1^+\ I_2^+, F_1^+\ F_2^+, -T_1^-\ T_2^-, -(-I_1^-{-}\ I_2^-\ -I_1^-\ I_2^-), -(-F_1^-{-}\ F_2^-\ -F_1^-\ F_2^-))$

$\tilde{a}_1.\tilde{a}_2 = (T_1^+\ T_2^+, I_1^+{+}I_2^+\ -I_1^+\ I_2^+\ +F_1^+\ +F_2^+\ -F_1^+\ F_2^+, -(-T_1^-{-}\ T_2^-\ -T_1^-\ T_2^-), -I_1^-\ \ I_2^-\ , -F_1^-\ F_2^-)$,

where λ > 0.

Definition 4. Let $\tilde{a}_1$= (T_1^+,I_1^+,F_1^+,T_1^-,I_1^-,F_1^-) be a bipolar neutrosophic number. Then, the score function s ($\tilde{a}_1$), accuracy function a ($\tilde{a}_1$) and certainty function c ($\tilde{a}_1$) of an NBN are defined as follows:

$$\tilde{S}(\tilde{a}_1) = (T_1^+ + 1 - I_1^+ + 1 - F_1^+ + 1 + T_1^- - I_1^- - F_1^-)/6 \quad (1)$$

$$\tilde{a}(\tilde{a}_1) = T_1^+ - F_1^+ + T_1^- - F_1^- \quad (2)$$

$$\tilde{c}(\tilde{a}_1) = T_1^+ - F_1^- \quad (3)$$

Definition 5. Let $\tilde{a}_1$= (T_1^+,I_1^+,F_1^+,T_1^-,I_1^-,F_1^-) and $\tilde{a}_2$= (T_2^+,I_2^+,F_2^+,T_2^-,I_2^-,F_2^-) be two bipolar neutrosophic numbers. The comparison method can be defined as follows:

- if $\tilde{s}(\tilde{a}_1) > \tilde{s}(\tilde{a}_2)$, then $\tilde{a}_1$ is greater than $\tilde{a}_2$, that is, $\tilde{a}_1$ is superior to $\tilde{a}_2$, denoted by $\tilde{a}_1$>$\tilde{a}_2$
- $\tilde{s}(\tilde{a}_1) = \tilde{s}(\tilde{a}_2)$ and $\tilde{a}(\tilde{a}_1) > \tilde{a}(\tilde{a}_2)$, then $\tilde{a}_1$ is greater than $\tilde{a}_2$, that is, $\tilde{a}_1$ is superior to $\tilde{a}_2$, denoted by $\tilde{a}_1 < \tilde{a}_2$;
- if $\tilde{s}(\tilde{a}_1) = \tilde{s}(\tilde{a}_2)$, $\tilde{a}(\tilde{a}_1) = \tilde{a}(\tilde{a}_2)$) and $\tilde{c}(\tilde{a}_1) > \tilde{c}(\tilde{a}_2)$, then $\tilde{a}_1$ is greater than $\tilde{a}_2$, that is, $\tilde{a}_1$ is superior to $\tilde{a}_2$, denoted by $\tilde{a}_1$>$\tilde{a}_2$;
- if $\tilde{s}(\tilde{a}_1) = \tilde{s}(\tilde{a}_2)$, $\tilde{a}(\tilde{a}_1) = \tilde{a}(\tilde{a}_2)$) and $\tilde{c}(\tilde{a}_1) = \tilde{c}(\tilde{a}_2)$, then $\tilde{a}_1$ is equal to $\tilde{a}_2$, that is, $\tilde{a}_1$ is indifferent to $\tilde{a}_2$, denoted by $\tilde{a}_1$=$\tilde{a}_2$.

Definition 6. Let $\tilde{a}_j$= (T_j^+,I_j^+,F_j^+,T_j^-,I_j^-,F_j^-) (*j* = 1, 2,…, *n*) be a family of bipolar neutrosophic numbers. A mappingA_ω: $Q_n \to Q$ is called bipolar neutrosophic weighted average operator if it satisfies the condition: $A_w(\tilde{a}_1,\tilde{a}_2,\ldots,\tilde{a}_n)=\sum_{j=1}^{n}\omega_j\tilde{a}_j$ =⟨ $1-\prod_{j=1}^{n}(1-T_j^+)^{\omega j}$, $\prod_{j=1}^{n} I_j^{+\omega j}$, $\prod_{j=1}^{n} F_j^{+\omega j}$,- $\prod_{j=1}^{n}(-T_j^-)^{\omega j}$, -1($\prod_{j=1}^{n}(1-(-I_j^-))^{\omega j}$), - (1 - $\prod_{j=1}^{n}(1-(-F_j^-))^{\omega j}$)), where ω_j is the weight of $\tilde{a}_j$ (*j* = 1,2, … , *n*), ω_j ∈ [0,1] and $\sum_{j=1}^{n}\omega_j$ =1.

4. Methodology

In this section, the steps of the suggested bipolar neutrosophic with TOPSIS framework are presented in details.

Step 1. Organize a committee of experts and determine the goal, the alternatives and the valuation criteria. Suppose that experts want to appreciate the collection of n criteria and m alternatives. Experts are symbolized by Ex_E = {Ex_1, Ex_2, Ex_3}, where E = 1, 2, ..., E, and alternatives by A_i = {A_1, A_2, ..., A_m}, where i = 1, 2, ..., m, assessed on n criteria c_j = {c_1, c_2, .., c_n}, j = 1, 2, ..., n.

Step 2. Depict and design the linguistic scales to describe experts, and set the alternatives.

Step 3. Obtain experts' judgments on each element.

Based on previously knowledge and experience, experts are demanded to convey their judgments. Every expert gives his / her judgment on every of these elements.

Step 4. Obtain the conversion of (BNNs) bipolar neutrosophic numbers.

When all experts give their valuations on each element. Let $R^k{}_{ij}$ be a (BN) decision matrix of the K^{th} DMs for calculating weights of criteria by opinions of DMs, then:

$$R^k{}_{ij} = \begin{bmatrix} r^k{}_{11} & \cdots & r^k{}_{1n} \\ \vdots & \ddots & \vdots \\ r^k{}_{m1} & \cdots & r^k{}_{mn} \end{bmatrix}, k \in K \quad (4)$$

where $r^k{}_{ij} = [T^+(x),\ I^+(x), F^+(x)\ T^-(x),\ I^-(x), F^-(x)]$, k = 1, 2, …, K, i = 1, 2, …, m, j = 1,2, …, n.

Step 5. Calculating the weights of experts.

Experts' judgments are collected by using the following equation:

$$r^k{}_{ij} = \frac{[T^+(x)_{n1}, I^+(x)_{n1}, F^+(x)_{n1},\ T^-(x)_{n1}, I^-(x)_{n1}, F^-(x)_{n1}]}{n} \quad (5)$$

Step 6. Construct the evaluation matrix.

Build the evaluation matrix $A_i \times C_j$ with the assistance of BNNS to evaluate the ratings of alternatives with respect to each criterion. Let $R^k{}_{ij}$ be a (BN) decision matrix of the K^{th}experts, then:

$$R^k{}_{ij} = \begin{bmatrix} r^k{}_{11} & \cdots & r^k{}_{1n} \\ \vdots & \ddots & \vdots \\ r^k{}_{m1} & \cdots & r^k{}_{mn} \end{bmatrix}, k \in K \quad (6)$$

where $r^k{}_{ij} = [T^+(x),\ I^+(x), F^+(x)\ T^-(x),\ I^-(x), F^-(x)]$, k = 1, 2, …, K, i = 1, 2, …, m, j = 1,2, …, n.

Step 7. Aggregate the final evaluation matrix.

Using Eq.7, aggregate the crisp values of evaluation matrices into a final matrix.

$$\tilde{a}_{ij} = \frac{\tilde{a}_{ij}{}^1 + \dots\dots\dots + \tilde{a}_{ij}{}^n}{n} \quad (7)$$

Then, normalize the obtained matrix by Eq. 8.

$$H_{rt} = \frac{x_{rt}}{\sqrt{\sum_{i=1}^m x_{rt}{}^2}};\ r = 1, 2\ldots m;\ t = 1, 2\ldots n. \quad (8)$$

After that, calculate the weight matrix by Eq. 9.

$$Q_{rt} = w_z \times H_{rt} \quad (9)$$

Step 8. Define Ideal Solution A^+, A^-.

Calculate the positive and negative ideal solution using Eqs. (10, 11).

$$A^+ = \{< \max\ (\delta_{ij} | i = 1, 2, \ldots, m) |\ j \in J^+ >, < \min\ (\delta_{ij} | i = 1, 2, \ldots, m) |\ j \in J^- >\} \quad (10)$$

$$A^- = \{< \min\ (\delta_{ij} | i = 1, 2, \ldots, m) |\ j \in J^+ >, < \max\ (\delta_{ij} | i = 1, 2, \ldots, m) |\ j \in J^- >\} \quad (11)$$

Step 9. Positive and Negative Ideal Solution $S^+{}_i$, $S^-{}_i$.

Calculate the Euclidean distance between positive solution ($S^+{}_i$) and negative ideal solution ($S^-{}_i$) using Eqs. (12, 13).

$$S^{+}_{i} = \sqrt{\sum_{j=1}^{n}(\delta_{ij} - \delta_j^{+})^2} \quad i = 1, 2, \dots, m, \tag{12}$$

$$S^{-}_{i} = \sqrt{\sum_{j=1}^{n}(\delta_{ij} - \delta_j^{-})^2} \quad i = 1, 2, \dots, m \tag{13}$$

Step 10. Rank the alternatives based on closeness coefficient.

$$P_i = \frac{S^{-}_{i}}{S^{+}_{i} + S^{-}_{i}} \quad i = 1, 2, \dots, m \tag{14}$$

5. Numerical Example

We presented in this area a numerical case, which requires techniques and information investigation to test the ability and effectiveness of proposed structure for determination of the best aircraft.

5.1. Case Study

In an exertion of leading the overview, 250 surveys are conveyed to authorize visit directs in 21 general travel offices. The reason of limiting the capability of respondents was that we wished respondents had the experience of going with all carriers to be assessed. The authorized visit aides were the most normal decisions because of their regular voyages. Among the 250 overviews, 211 were returned for an arrival pace of 47%. The other statistic measurements were: 21% were at their age of 21–41; 99.05% got in any event secondary school training; normal working knowledge in the travel industry was 5.9 years. The poll of administration quality assessment mostly was made out of two sections: inquiries for assessing the general significance of criteria and aircraft's presentation relating to every measure. TOPSIS technique was utilized in getting the overall load of criteria and positioning of options. Concerning the presentation comparing to criteria of each carrier, we utilized semantic articulation to quantify the communicated exhibition. So as to set up the enrollment capacity related with each semantic articulation term, we requested that respondents indicate the range from 0 to 1 comparing to etymological term 'disappointed', 'reasonable', 'fulfilled' and 'exceptionally fulfilled'. These score were later pooled to align the participation capacities. We picked three noteworthy air transporters as the objects of this experimental examination. Carrier A, the most established aircraft in Egypt, with over 30 year's history, gains the most noteworthy piece of the overall industry by about 30%. The piece of the pie of aircraft B, despite the fact that is just 20% as of now, is quickly developing a result of the positive picture and notoriety. Carrier C is a preferably youthful jetliner with less over 10 years of activity history. The piece of the pie of carrier C is the least out of the three aircrafts at about 13%. There are three experts: Ex_1, Ex_2, $Ex_3$and Ex_3, and three alternatives A, B and C .For evaluating the airlines alternatives, seven criteria are considered as selection factors: C_1 (Appearance of crew), C_2 (Food), C_3 (Professional skill of crew), C_4 (Customer complaints handling), C_5 (Responsiveness of crew), C_6 (Safety) and C_7 (Timeliness).

5.2. The Calculation Process

Step 1. Organize a committee of experts and determine the goal, alternatives and valuation criteria.

Step 2. Determine the appropriate linguistic variables for weights W_n of criteria C_n and alternatives A_n with regard to each criterion. Each linguistic variable is a bipolar neutrosophic number. For criteria weights and for compilation alternatives, the linguistic variables are as in Table 1.

Table 1. Linguistic terms for evaluation criteria and alternatives.

Linguistic terms	Bipolar neutrosophic number $[T^+(x), I^+(x), F^+(x)\ T^-(x), I^-(x), F^-(x)]$
Excessively Good (EG)	⟨0.9, 0.1, 0.0, 0.0 , - 0.8, - 0.9⟩
Very Good (VG)	⟨1.0, 0.0, 0.1, - 0.3 , - 0.8, - 0.9⟩
Midst Good (MG)	⟨0.8, 0.5, 0.6, - 0.1 , - 0.8, - 0.9⟩
Perfect (P)	⟨0.7, 0.6, 0.5, - 0.2 , - 0.5, - 0.6⟩
Approximately Similar (AS)	⟨0.5, 0.2, 0.3, - 0.3 , - 0.1, - 0.3⟩
Bad (B)	⟨0.4, 0.4, 0.3, - 0.5 , - 0.2, - 0.1⟩
Midst Bad (MB)	⟨0.3, 0.1, 0.9, - 0.4 , - 0.2, - 0.1⟩
Very Bad (VB)	⟨0.2, 0.3, 0.4, - 0.8 , - 0.6, - 0.4⟩
Excessively Bad (EB)	⟨0.1, 0.9, 0.8, - 0.9 , - 0.2, - 0.1⟩

Step 3. Calculating the weights of experts

Table 2 presents the criteria weights according to all experts, after deciding linguistic variables to each expert. Convert the linguistic variables into bipolar neutrosophic numbers. Use Eq. 5 to aggregate weights in BNNs. Then, employ Eq. 1 to calculate the crisp weight values. After that, make a normalization procedure on the previous values, as in Table 3.

Table 2. Criteria weights according to all experts.

Exs	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Ex_1	⟨EG⟩	⟨MG⟩	⟨AS⟩	⟨VG⟩	⟨MB⟩	⟨EG⟩	⟨EG⟩
Ex_2	⟨MB⟩	⟨B⟩	⟨VB⟩	⟨P⟩	⟨VB⟩	⟨MG⟩	⟨P⟩
Ex_3	⟨P⟩	⟨AS⟩	⟨MB⟩	⟨AS⟩	⟨MG⟩	⟨AS⟩	⟨EB⟩
Ex_4	⟨VG⟩	⟨EB⟩	⟨P⟩	⟨EG⟩	⟨VG⟩	⟨B⟩	⟨AS⟩

Table 3. The normalized criteria weights.

Weight $\tilde{w}_n$	Aggregation weights in BNNs	crisp	Normalized Weight
C_1	[0.725, 0.2, 0.375, - 0.225, - 0.575, - 0.625]	0.6875	0.17
C_2	[0.450 , 0.50, 0.500, - 0.45 , - 0.325, - 0.35]	0.4458	0.09
C_3	[0.425, 0.3, 0.525, - 0.425 , - 0.350, - 0.350]	0.4792	0.11
C_4	[0.775, 0.225, 0.225, - 0.20 , - 0.55, - 0.675]	0.7250	0.21
C_5	[0.575, 0.225, 0.500, - 0.4 , - 0.600, - 0.575]	0.6042	0.14
C_6	[0.650, 0.300, 0.3, - 0.225 , - 0.475, - 0.550]	0.6417	0.15
C_7	[0.550, 0.450, 0.40, - 0.35 , - 0.400, - 0.475]	0.5375	0.13

Step 4. Construct the evaluation matrix.

Obtain the final decision matrix by making the aggregation procedure of experts' priorities and preferences, as in Table 4. Calculate the crisp values of matrices and insert them into the aggregated matrix.

Table 4. The aggregated crisp values of decision matrix.

C_n/ A_n	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A	0.48	0.69	0.5	0.64	0.55	0.51	0.82
B	0.53	0.73	0.55	0.67	0.51	0.84	0.69
C	0.85	0.48	0.63	0.54	0.61	0.63	0.76

Apply the normalization process by using Eq. 8 to obtain the normalized evaluation matrix, as presented in Table 5.

Table 5. The normalized decision matrix.

C_n/ A_n	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A	0.43	0.62	0.51	0.60	0.57	0.44	0.62
B	0.48	0.66	0.56	0.62	0.53	0.72	0.53
C	0.77	0.43	0.65	0.50	0.63	0.54	0.58

Build the weighted matrix by multiplying the normalized evaluation matrix by the weights of criteria using Eq. 9, as in Table 6.

Table 6. The weighted matrix.

C_n/ A_n	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Weight	0.17	0.09	0.11	0.21	0.14	0.15	0.13
A	0.073	0.055	0.056	0.126	0.079	0.066	0.081
B	0.082	0.059	0.061	0.130	0.074	0.108	0.068
C	0.130	0.039	0.072	0.105	0.088	0.081	0.075

Step 5. Define Ideal Solution A^+, A^-.

Define the ideal solutions using Eqs. 10 and 11.

Step 6. Positive and Negative Ideal Solution $S^+{}_i$, $S^-{}_i$.

Calculate the Euclidean distance between positive solution ($S^+{}_i$) and negative ideal solution ($S^-{}_i$) using Eqs. 13 and 14.

Step 7. Rank the alternatives based on closeness coefficient.

Calculate the performance score using Eq. 14, and make the last ranking of alternatives as presented in Table 7 and in Figure.1.

Table 7. The TOPSIS result and ranking of alternatives.

C_n/ A_n	S^+_1	S^-_1	p_i	Rank
A	0.073	0.029	0.28	3
B	0.053	0.053	0.50	2
C	0.059	0.065	0.53	1

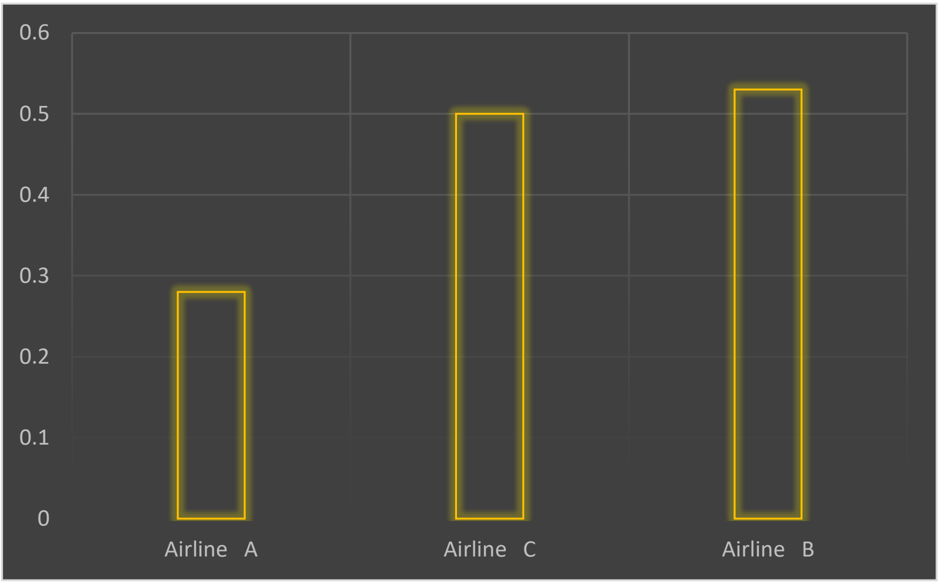

Figure 1. Ranking the alternatives using TOPSIS under Neutrosophic.

6. Conclusion

The idea of value administration goes past the specialized parts of giving the administration Fit incorporates clients' impression of what the administrations ought to be and how the administrations is to be passed on. In examining the two concerns, we build up the systems for recognizing the most significant characteristics of administration quality for clients and catch clients' evaluation of three aircrafts dependent on these traits.

The assessment methodology comprises of the accompanying advances: (1) distinguish the assessment criteria for carrier administration quality; (2) survey the normal significance of every model by TOPSIS over every one of the respondents. (3) Represent the presentation evaluation of air bearers for every paradigm by neutrosophic numbers, which expressly endeavors to precisely catch the genuine inclination of assessors. Singular appraisal at that point is amassed as a general evaluation for every carrier under every rule. (4) Use TOPSIS as the principle gadget in positioning the administration nature of the three air transporters.

The noteworthy discoveries of this investigation spread a few viewpoints. Clients are for the most part worried about the physical part of the administration and less worried about the sympathy perspective. The finding proposes that aircrafts ought to keep up their physical highlights about a specific level and keep redesign important.

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