World Academy of Science, Engineering and Technology
International Journal of Aerospace and Mechanical Engineering
Vol:16, No:12, 2022

Multiple Criteria Decision Making for Turkish Air Force Stealth Fighter Aircraft Selection

C. Ardil

***Abstract*—**Neutrosophic logic decision analysis is proposed as a method of stealth fighter aircraft selection for Turkish Air Force. The opinion of experts is employed to rank the alternatives across a set of criteria. The analyst uses neutrosophic logic numbers to describe the experts' preferences. This approach can handle the situation in the case of unavailability of precise data, which is most commonly the case in stealth fighter aircraft selection. Neutrosophic logic numbers can consider the imprecision of the factors affecting decision making such as stealth analysis, survivability analysis, and performance analysis. Neutrosophic logic ranking is achieved using weighted arithmetic operator and weighted geometric operator and the alternatives are ranked from best to worst. An example is also presented to illustrate the applicability and effectiveness of the proposed method.

***Keywords*—**Neutrosophic set theory, stealth fighter aircraft selection, multiple criteria decision-making, neutrosophic logic decision making, Turkish Air Force, MCDM.

I. Introduction

Neutrosophic logic sheds light on real life problems with epistemic logic applications in learning theory as well as game theory and decisions. Neutrosophic logic studies have applications in the epistemic foundations of artificial intelligence (AI), computational linguistics, and game theory, respectively. At the same time, extensive work is continuing the logical foundations of game theory, applying both epistemic logic and the various formalisms in AI.

The logic of knowledge is explored using a rich multimodal environment, whose core semantics are provided by learning theory. Epistemic structures in multi-agent systems, especially in games, are investigated using various modal logics. Neutrosophic logic is particularly interested in the use of such contemporary logics and the role of logical expression as tools for describing and analyzing such systems [1].

Neutrosophic logic combines probabilistic and model-theoretic approaches, providing an unusually detailed consideration of conditional logic. It highlights various approaches to relevantistic and related logic and highlights the problem of linking formal systems to the motivating ideas behind intuitionistic mathematics [2]. The need to revise classical logic before it can be applied to an ambiguous and vague language is discussed [3].

The most important developments in contemporary neutrosophic logic and controversies in neutrosophic implications and applications of formal symbolic logic were presented [4]. Neutrosophic logic is a comprehensive start by comparing conventional classical logic with constructivist or intuitive logic, quantification and syllogism, modal logic and set theory [5].These neutrosophic logic subjects are essentially sentential logic, quantificational logic, sentential modal logic, quantification, and modality, set theory, incompleteness, term logic, and modal term logic. So, logical forms explain both the detailed problems-validity, truth functionality, conditionals and probabilities, quantification, necessity, the project of formalization- involved in finding logical forms and also the theoretical underpinnings of neutrosophic logic [6].

In parallel with the discussions in philosophical logic, the efforts to produce effective solutions to real life problems by expanding the classical logic framework in mathematics and computer sciences have led to the emergence of different quantitative theories. The uncertainty, ambiguity, and vagueness associated in real life applications have widely been discussed through probability theory, fuzzy set theory, rough set theory, vague set theory, intuitionistic fuzzy set theory, interval mathematics, and neutrosophic set theory methods. Each of these theories has its own benefits and inherent limitations when it comes to handling uncertainties and vagueness in real life problems.

For instance, the degree of membership / truth (*T*) , $A=\{(x,\mu_A(x)) \mid \mu_A(x)\in[0,1]\ \forall x\in X\}$, was defined through the fuzzy set in 1965 by Zadeh [7]. The degree of non membership / falsehood (*F*) in the following form was $A=\{(x,\mu_A(x),\nu_A(x)) \mid \mu_A(x)\in[0,1],\nu_A(x)\in[0,1]\ \forall x\in X\}$ defined through the intuitionistic fuzzy set in 1986 by Atanassov [8]. The degree of indeterminacy/neutrality (*I*) as independent component was defined through the neutrosophic set on three components (*T*, *I*, *F*) = (truth, indeterminacy, falsehood) in in 1995 by Smarandache [9]. The neutrosophic set components (*T*, *I*, *F*) are standard or non-standard real subsets of $]^-0,1^+[$ with not necessarily any connection between them $^-0 \le T_{A(x)} + I_{A(x)} + F_{A(x)} \le 3^+$ [9].

Reviewing the state-of-the-art literature [10-30], this article aims to select the best stealth fighter aircraft for the Turkish Air Force by using neutrosophic logic analysis in the multiple criteria decision-making process. Real-life applications in science and technology all have an inherent and pervasive ambiguity, ambiguity and uncertainty in problem data for multi-criteria decision making.

The uncertainty and vagueness are also inherent in the neutrosophic logic propositions. Neutrosophic logic propositions assigns neutrosophic values to sentences based on neutrosophic values assigned to three logical independent

C. Ardil is with the National Aviation Academy, Baku, Azerbaijan. https://orcid.org/0000-0003-2457-7261

components; neutrosophic truth (P_T), neutrosophic indeterminacy (P_I), and neutrosophic falsehood (P_F). Here, the three logical independent neutrosophic components (P_T, P_I, P_F) are essentially defined:

a) Neutrosophic truth (P_T) is the body of real things, events, and facts. It is the state of being the case (fact). It is a judgment, proposition, or idea that is true or accepted as true. It is the body of true statements and propositions. It is the property (as of a statement) of being in accord with fact or reality. It is fidelity to an original or to a standard. It is sincerity in action, character, and utterance. It is the state of being able to accurately predict the outcome or the result.

b) Neutrosophic indeterminacy (P_I) is the quality or state of being indeterminate. Indeterminate is not definitely or precisely determined or fixed. It is not known in advance. It is not leading to a definite end or result. It is having an infinite number of solutions. It is a state of uncertainty about the very existential nature of an outcome or a result. The indeterminacy of something is its quality of being uncertain or vague. Indeterminacy is similar to ambiguity. It is the condition of being indeterminate.

c) Neutrosophic falsehood (P_F) is an untrue statement, or absence of truth or accuracy. False is not genuine, intentionally untrue, adjusted or made so as to deceive, intended or tending to mislead. False is not true, not faithful or loyal, lacking naturalness or sincerity. It is not essential or permanent. It is fitting over a main part to strengthen it, to protect it, or to disguise its appearance. It is inaccurate in pitch, based on mistaken ideas, inconsistent with the facts, threateningly sudden or deceptive. It is the state of not being able to accurately predict the outcome or the result.

The remainder of this paper is structured as follows. The neutrosophic logic set is presented in the next section. Then, in section II, an MCDM approach based on neutrosophic logic is proposed. In Sections III and VI, respectively, a numerical illustration of the stealth fighter aircraft selection problem and a formal conclusion are provided.

II. Methodology

A. Neutrosophic logic preliminaries

Neutrosophic logic is the branch of logic that investigates the application of logical principles to neutrosophic problems. Neutrosophic logic is a form of logic in which a proposition, statement, or solution is not precisely defined and leaves room for multiple interpretations with three logical components [1-9].

Definition 1. [7,8,9] Let *X* be a space of points (objects) with a class of elements in *X* denoted by *x*. A neutrosophic set (*NS*) *A* in *X* is defined by a neutrosophic truth -membership function $P_{T,A(x)}$, an neutrosophic indeterminacy-membership function $P_{I,A(x)}$, and a neutrosophic falsehood-membership function $P_{F,A(x)}$. So, a neutrosophic set (*NS*) *A* in *X* NS can be expressed as follow:

$$P = \left\{ \left\langle x, P_{T,A(x)}, P_{I,A(x)}, P_{F,A(x)} \right\rangle \mid \forall x \in X \right\} \quad (1)$$

where $P_{T,A(x)} \in [0,1]$, $P_{I,A(x)} \in [0,1]$, $P_{F,A(x)} \in [0,1]$ for $\forall x \in X$. Meanwhile, the sum of components $P_{T,A(x)}$, $P_{I,A(x)}$, and $P_{F,A(x)}$ fulfills the condition,

a) *when all three components are independent;*

$$0 \le P_{T,A(x)} + P_{I,A(x)} + P_{F,A(x)} \le 3 \quad (2)$$

b) *when two components are dependent, while the third one is independent from them;*

$$0 \le P_{T,A(x)} + P_{I,A(x)} + P_{F,A(x)} \le 2 \quad (3)$$

c) *when all three components are dependent.*

$$0 \le P_{T,A(x)} + P_{I,A(x)} + P_{F,A(x)} \le 1 \quad (4)$$

Definition 2. The complement of a neutrosophic number (NN) A is denoted by A^C and defined as $P^C_{T,A(x)} = P_{T,A(x)}$,

$P^C_{I,A(x)} = 1 - P_{I,A(x)}$, and $P^C_{F,A(x)} = P_{F,A(x)}$

$$A^C = \left\{ \left\langle x, P_{T,A(x)}, 1 - P_{I,A(x)}, P_{F,A(x)} \right\rangle x \in X \right\} \quad (5)$$

Definition 3. A neutrosophic set *A* is contained in the other NS *B*, $A \subseteq B$, iff $P_{T,A(x)} \le P_{T,B(x)}$, $P_{I,A(x)} \ge P_{I,B(x)}$ and $P_{F,A(x)} \ge P_{F,B(x)}$ for $\forall x \in X$.

Definition 4. Two NSs *A* and *B* are equal, written as $A = B$, iff $A \subseteq B$, and $B \subseteq A$.

Definition 5. Let $x = (P_{Tx)}, P_{Ix}, P_{Fx})$ and $y = (P_{Ty)}, P_{Iy}, P_{Fy})$ be two NNs, then operations can be defined as follows:

$$\begin{aligned}
&1.\ x^C = (P_{Fx}, 1 - P_{Ix}, P_{Tx}) \\
&2.\ x \oplus y = (P_{Tx} + P_{Ty} - P_{Tx}P_{Ty}, P_{Ix}P_{Iy}, P_{Fx}P_{Fy}) \\
&3.\ x \otimes y = (P_{Tx}P_{Ty}, P_{Ix} + P_{Iy} - P_{Ix}P_{Iy}, P_{Fx} + P_{Fy} - P_{Fx}P_{Fy}) \\
&4.\ \lambda x = (1 - (1 - P_{Tx})^{\lambda}, (P_{Ix})^{\lambda}, (P_{Fx})^{\lambda}),\ \lambda > 0 \\
&5.\ x^{\lambda} = ((P_{Tx})^{\lambda}, 1 - (1 - P_{Ix})^{\lambda}, 1 - (1 - (P_{Fx})^{\lambda}),\ \lambda > 0
\end{aligned} \quad (6)$$

Definition 6. Let $x = (P_{T(x)}, P_{I(x)}, P_{F,(x)})$ be a neutrosophic number (NN), then the neutrosophic score function $S(x)$ is defined as follows:

$$S(x) = (1 + P_{T(x)} - 2P_{I(x)} - P_{F(x)}) / 2 \text{ , } \in [-1,1] \quad (7)$$

Definition 7. Let $x = (P_{T(x)}, P_{I(x)}, P_{F,(x)})$ be a NN, then the philosophical accuracy function $H(x)$ is defined as follows:

$$H(x) = P_{T(x)} - P_{I(x)}(1 - P_{T(x)}) - P_{F(x)}(1 - P_{I(x)}) \text{ , } \in [-1,1] \quad (8)$$

In the sequel, the set of all NNs in *X* will be denoted by NS(X). A NS value is denoted by $A = (a,b,c)$.

Two weighted aggregation operators related to NSs are given as follows:

Definition 8. Let $A_k(1,2,...,n) \in NN(X)$. The neutrosophic weighted average operator is defined as

$$F_\omega = (A_1, A_2, ..., A_n) = \sum_{k=1}^{n} \omega_k A_k \quad (9)$$

$$= \left(1 - \prod_{k=1}^{n} (1 - P_{T,A(x)})^{\omega_k}, \prod_{k=1}^{n} (P_{I,A(x)})^{\omega_k}, \prod_{k=1}^{n} (P_{F,A(x)})^{\omega_k}\right)$$

where ω_k is the weight of $A_k(1,2,...,n)$, $\omega_k \in [0,1]$ and $\sum_{k=1}^{n} \omega_k = 1$. Especially, assume that $(\omega_k) = 1/n$ $(k = 1,2,...,n)$, then F_ω is called an arithmetic average operator for NNs.

Similarly, the neutrosophic weighted geometric average operator can be defined as follows:

Definition 9. Let $A_k(1,2,...,n) \in NN(X)$. The neutrosophic weighted geometric average operator is defined as

$$G_\omega = (A_1, A_2, ..., A_n) = \prod_{k=1}^{n} A_k^{\omega_k} \quad (10)$$

$$= \left(\prod_{k=1}^{n} (P_{T,A(x)})^{\omega_k}, 1 - \prod_{k=1}^{n} (1 - P_{I,A(x)})^{\omega_k}, 1 - \prod_{k=1}^{n} (1 - P_{F,A(x)})^{\omega_k}\right)$$

where ω_k is the weight of $A_k(1,2,...,n)$, $\omega_k \in [0,1]$ and $\sum_{k=1}^{n} \omega_k = 1$. Especially, assume that $(\omega_k) = 1/n$ $(k = 1,2,...,n)$, then G_ω is called a geometric average operator for NNs.

The aggregation results F_ω and G_ω are still NNs. Obviously, there are different emphasis points between *Definitions 9* and *10*. The weighted arithmetic average operator indicates the group's influence, so it is not very sensitive to $A_k(1,2,...,n) \in NN(X)$, whereas the weighted geometric average operator indicates the individual influence, so it is more sensitive to $A_k(1,2,...,n) \in NN(X)$.

B. Ranking by score function

Example 1. Let $A_1 = (0.6, 0.3, 0.1)$, $A_2 = (0.8, 0.1, 0.3)$, and $A_3 = (0.7, 0.5, 0.4)$ be three neutrosophic values for two alternatives.

Then, by applying *Definition 6*, one can obtain

$$S(A_1) = \frac{1 + 0.6 - 2x0.3 - 0.1}{2} = 0.45$$

$$S(A_2) = \frac{1 + 0.8 - 2x0.1 - 0.3}{2} = 0.65$$

$$S(A_3) = \frac{1 + 0.7 - 2x0.5 - 0.4}{2} = 0.15$$

In this case, the ranking order of alternatives is $A_3 \prec A_1 \prec A_2$, one can conclude that A_2 is the best choice.

C. Ranking by accuracy function

Example 2. Let $A_1 = (0.7, 0.2, 0.6)$, $A_2 = (0.6, 0.4, 0.2)$, and $A_3 = (0.7, 0.4, 0.3)$ be three neutrosophic values for two alternatives. Then, by applying *Definition 7*, Eq. 8, one can obtain

$$H(A_1) = 0.7 - 0.2x(1 - 0.7) - 0.6x(1 - 0.2) = 0{,}16$$

$$H(A_2) = 0.6 - 0.4x(1 - 0.6) - 0.2x(1 - 0.4) = 0.32$$

$$H(A_3) = 0.7 - 0.4x(1 - 0.7) - 0.1x(1 - 0.4) = 0.52$$

In this case, the ranking order of alternatives is $A_1 \prec A_2 \prec A_3$, one can conclude that A_3 is the best choice.

From the analysis above, one constructs a method for multiple criteria decision-making based on the score function $S(a_k)$ and the accuracy function $H(a_k)$, which are criterion values for alternatives and are defined as follows.

III. Application

A. Neutrosophic logic in multiple criteria decision making

Here, a neutrosophic logic method for weighted multiple-criteria decision-making problems is proposed.

Suppose that $A = \{A_1, A_2, ..., A_m\}$ be the set of alternatives and $C = \{C_1, C_2, ..., C_n\}$ be a set of criteria. Suppose that the weight of the criterion $C_j\,(j = 1,..,n)$, stated by the decision-maker, is ω_j, $\omega_j \in [0,1]$ and $\sum_{j=1}^{n} \omega_j = 1$. Thus, the characteristic of the alternative $A_k(k = 1,2,...,m)$ is introduced by the following NS:

B. Neutrosophic logic MCDM model

Let $A_k = \left\{ \left\langle C_j, P_{T,A(x)}(C_j), P_{I,A(x)}(C_j), P_{F,A(x)}(C_j) \right\rangle x \in X \right\}$ be a neutrosophic set (NS) *A* in *X* is structured with criteria weights, where $0 \le P_{T,A(x)}(C_j) + P_{I,A(x)}(C_j) + P_{F,A(x)}(C_j) \le 3$, $P_{T,A(x)}(C_j) \ge 0$, $P_{I,A(x)}(C_j) \ge 0$, $P_{F,A(x)}(C_j) \ge 0$, $j = 1, 2, ..., n$ and $k = 1, 2, ..., m$.

The NS value that is the triple of values for C_j is denoted by $a_{kj} = (a_{kj}, b_{kj}, c_{kj})$ where a_{kj} indicates the degree that the alternative A_k satisfies the criterion C_j, and b_{kj} indicates the degree that the alternative A_k is indeterminacy on the criterion C_j, where as c_{kj} indicates the degree that the alternative A_k does not satisfy the criterion C_j given by the decision-maker.

Using the proposed MCDM model, one can express a decision matrix $D = [a_{kj}]_{mxn}$.

The aggregating neutrosophic number a_k for $A_k (k = 1, 2, ..., m)$ is $a_k = (a_k, b_k, c_k) = F_{k\omega}(A_{k1}, A_{k2}, ..., A_{kn})$ or $a_k = (a_k, b_k, c_k) = G_{k\omega}(A_{k1}, A_{k2}, ..., A_{kn})$, which is obtained by *Definition 9 or Definition 10* $a_k = (a_k, b_k, c_k) = F_{k\omega}(A_{k1}, A_{k2}, ..., A_{kn})$.

The procedural steps of the suggested method can be summed up as follows:

Step 1. Obtain the weighted arithmetic average values by using Eq. (9) or the weighted geometric average values by Eq. (10).

Step 2. Obtain the score (or accuracy) $S(A_1)$ of neutrosophic value a_k ($k = 1, 2, ..., m$) by using Eq. (7).

Step 3. Rank the alternative $A_k (k = 1, 2, ..., m)$ and choose the best one(s) according to (a_k) ($k = 1, 2, ..., m$).

Example 3. Let us consider a neutrosophic multiple criteria decision making problem for Turkish Air Forces. There is a national air force command, which wants to acquire the best stealth fighter aircraft for strategic, tactical, and operational requirements.

There is a panel with three possible alternatives to acquire the stealth fighter aircraft: (1) A_1 is *Lockheed Martin F-35 Lightning II (single engine)*; (2) A_2 is a *Chengdu J-20 (twin engine)*; (3) A_3 is a *TAI MMU TF-X (twin engine)*. The air force command must decide according to three criteria $C_j (j = 1, .., J)$ given below: (1) C_1 is the stealth analysis; (2) C_2 is the survivability analysis; (3) C_3 is the performance analysis. The three chosen criteria are benefit-type criteria. (the bigger the better) [10-30].

In this context, when it comes to providing critical defense requirements, purchasing cost, maintenance cost and environmental impact factor can be ignored at the expense of national defense and security policy. Then, the weight vector $\omega_j (j = 1, .., n)$ of the criteria is given by are $\omega_1 = 0.35$ $\omega_2 = 0.25$, and $\omega_3 = 0.40$. Thus, after the expert panel has analyzed the three potential alternatives considering the three criteria, the following neutrosophic decision matrix (Table 1) can be obtained:

Table 1. Neutrosophic decision matrix

Options (A_k)	Decision criteria (C_j)		
	C_1	C_2	C_3
A_1	0.4,0.2,0.3	0.4,0.2,0.3	0.2,0.2,0.5
A_2	0.6,0.1,0.2	0.7,0.3,0.2	0.8,0.3,0.2
A_3	0.7,0.2,0.3	0.5,0.2,0.3	0.5,0.3,0.2

Assume that the importance weights of C_1, C_2, and C_3 are each 0.35, 0.25, and 0.40. Then, the method developed is utilized to find the ideal alternative (s).

Step 1. The weighted arithmetic average value a_k for $A_k (k = 1, 2, ..., m)$ is computed by using Eq. (9) shown in Table 2 as follows:

Table 2. Weighted arithmetic average value (a_k)

Options (A_k)	Decision criteria (C_j)		
	C_1	C_2	C_3
A_1	0,3268	0,2000	0,3680
A_2	0,7179	0,2042	0,2000
A_3	0,5819	0,2352	0,2551

Step 2. Deneutrosophication is a process to evaluate real output from neutrosophic information. By using Eq. (7), the deneutrosophication logic procedure is carried out, then, the ranking order of alternatives $S(a_k)$ (*k*=1,2,3,4) is obtained as shown in Table 3.

Table 3. Ranking order (R_i) of stealth fighter aircraft alternatives according to the score degrees of $S(a_k)$ (*k*=1,2,3,4)

Options (A_k)	The ranking pattern of stealth fighter aircraft alternatives		
	$S(a_k)$	R_i	Aircraft Model
A_1	0,2794	3	J-20
A_2	0,5547	1	TF-X
A_3	0,4282	2	F-35

Following the MCDM analysis ($A_1 \prec A_3 \prec A_2$), one can conclude that A_2 (TF-X) is the best choice.

Step 3. By using Eq. (8), rank all alternatives according to the accuracy degrees of $H(a_k)$ (k=1,2,3,4):

Table 4. Ranking order (R_i) of stealth fighter aircraft alternatives according to the accuracy degrees of $H(a_k)$ (k=1,2,3,4)

Options (A_k)	The ranking pattern of stealth fighter aircraft alternatives		
	$H(a_k)$	R_i	Aircraft Model
A_1	-0,1022	3	J-20
A_2	0,5011	1	TF-X
A_3	0,2884	2	F-35

Following the MCDM analysis ($A_1 \prec A_3 \prec A_2$), one can conclude that A_2 (TF-X) is the best choice. Thus, the alternative A_2 (TF-X), Türkiye's national combat aircraft is the most desirable alternative based weighted arithmetic average operator.

Now, assuming the same weights for C_1, C_2, and C_3, one uses the weighted geometric average operator to determine the ideal alternative(s).

Step 1.The weighted geometric average value a_k for $A_k (k = 1, 2,..., m)$ is computed by using Eq. (10) shown in Table 5as follows:

Table 5. Weighted geometric average value (a_k)

Options (A_k)	Decision criteria (C_j)		
	C_1	C_2	C_3
A_1	0,3031	0,2000	0,3881
A_2	0,6996	0,2356	0,2000
A_3	0,5625	0,2416	0,2616

Step 2. By using Eq. (7), the deneutrosophication logic procedure is carried out, then, the ranking order of alternatives $S(a_k)$ (k=1,2,3,4) is obtained as shown in Table 6.

Table 6. Ranking order (R_i) of stealth fighter aircraft alternatives according to the score degrees of $S(a_k)$ (k=1,2,3,4)

Options (A_k)	The ranking pattern of stealth fighter aircraft alternatives		
	$S(a_k)$	R_i	Aircraft Model
A_1	0,2575	3	J-20
A_2	0,5142	1	TF-X
A_3	0,4088	2	F-35

Following the MCDM analysis ($A_1 \prec A_3 \prec A_2$), one can conclude that A_2 (TF-X) is the best choice.

Step 3. By using Eq. (8), rank all alternatives according to the accuracy degrees of $H(a_k)$ (k=1,2,3,4):

Table 7. Ranking order (R_i) of stealth fighter aircraft alternatives according to the accuracy degrees of $H(a_k)$ (k=1,2,3,4)

Options (A_k)	The ranking pattern of stealth fighter aircraft alternatives		
	$H(a_k)$	R_i	Aircraft Model
A_1	-0,1467	3	J-20
A_2	0,4760	1	TF-X
A_3	0,2584	2	F-35

Following the MCDM analysis ($A_1 \prec A_3 \prec A_2$), one can conclude that A_2 (TF-X) is the best choice. Thus, the alternative A_2 (TF-X), Türkiye's national combat aircraft is the most desirable alternative based weighted geometric average operator.

IV. Conclusion

Modern logic is a wonderful achievement of the human mind. The development of logic as the study of argument and the way premises support conclusions is also part and parcel of the neutrosophic logic. Logic is an attempt at reflecting on how one thinks, and ones attempt to describe what it is like to think well. The idea that human consciousness became self-conscious in this way is an inspiring and challenging realization.

Neutrosophic logic is the branch of philosophy that studies the relationship between formal logic and ordinary language, especially the extent to which the former can be held accurately to represent the latter. Neutrosophic logic investigates the basic logical tools standardly assumed in neutrosophic research. It covers classical logic and some of its extensions such as modal and higher-order logics, as well as non-classical logics. It discusses neutrosophic issues that motivate various logics, such as puzzles surrounding identity and opacity, conditionals, vagueness, and the nature of quantifiers.

Modern logic and philosophy of logic includes results ranging from such neutrosophic disciplines as logical philosophy and philosophy of logic to mathematical logic, a subfield of mathematics exploring the applications of formal logic to mathematics. Philosophy of logic is devoted to the investigation, analysis and reflection on issues arising in logic, while neutrosophic logic concerns questions about reference, truth, quantification, existence, entailment, predication, identity, modality, and necessity. A typical example of neutrosophic logic is the application of formal logical techniques to neutrosophic problems.

In this paper, the neutrosophic logic analysis was applied to select the best stealth fighter aircraft alternative using multiple criteria decision-making technique. Neutrosophic logic numbers can consider the imprecision of the factors affecting decision making such as stealth analysis, reliability analysis, and performance analysis of stealth fighter aircraft.

Neutrosophic logic ranking was achieved using weighted arithmetic operator and weighted geometric operator and the alternatives were ranked from best to worst. Finally, Türkiye's national combat aircraft (TAI TF-X) was selected as the best stealth fighter aircraft for Turkish Air Force.

References

[1] Carnegie Mellon University (2022, December 31). *Philosophical Logic*. Department of Philosophy , https://www.cmu.edu/dietrich/philosophy/research/areas/math-logic/philosophical-logic.html

[2] Burgess, J. P. (2012). *Philosophical Logic*. Princeton Foundations of Contemporary Philosophy, Aug 26, 2012, ISBN: 9780691156330.

[3] MacFarlane, J. (2021). *Neutrosophic logic - A Contemporary Introduction*. Routledge, New York, USA.

[4] Jacquette, D. (2006). *A Companion to Philosophical Logic*.Blackwell Publishing Ltd. ISBN:9780631216711. DOI:10.1002/9780470996751

[5] Englebretsen, G., Sayward, C. (2011). *Neutrosophic logic An Introduction to Advanced Topics*. Bloomsbury Publishing.

[6] Sainsbury, M. (2000*). Logical Forms: An Introduction to Philosophical Logic*. ISBN: 978-0-631-21679-7,Wiley-Blackwell.

[7] Zadeh L.A., (1965). Fuzzy Sets. *Information and Control*, 8, 338-353.

[8] Atanassov, K. T.(1986). Intuitionistic fuzzy sets. *Fuzzy Sets and Systems*,vol.20,no.1,pp.87–96,1986.

[9] Smarandache,F. (2003).*Neutrosophic Logic - Generalization of the Intuitionistic Fuzzy Logic*. https://arxiv.org/abs/math/0303009

[10] Ardil, C. (2022).Fuzzy Uncertainty Theory for Stealth Fighter Aircraft Selection in Entropic Fuzzy TOPSIS Decision Analysis Process. *International Journal of Aerospace and Mechanical Engineering*, 16(4), 93 - 102.

[11] Ardil, C. (2022). Vague Multiple Criteria Decision Making Analysis Method for Fighter Aircraft Selection. *International Journal of Aerospace and Mechanical Engineering*, 16(5),133-142.

[12] Ardil, C. (2022). Military Attack Helicopter Selection Using Distance Function Measures in Multiple Criteria Decision Making Analysis. *International Journal of Aerospace and Mechanical Engineering*, 16(2), 20 - 27.

[13] Ardil, C. (2022). Fighter Aircraft Selection Using Neutrosophic Multiple Criteria Decision Making Analysis. *International Journal of Computer and Systems Engineering*, 16(1), 5 - 9.

[14] Ardil, C. (2022). Fighter Aircraft Selection Using Fuzzy Preference Optimization Programming (POP). *International Journal of Aerospace and Mechanical Engineering*, 16(10), 279 - 290.

[15] Ardil, C. (2022). Aircraft Selection Using Preference Optimization Programming (POP).*International Journal of Aerospace and Mechanical Engineering*, 16(11), 292 - 297.

[16] Ardil, C. (2022). Aircraft Selection Problem Using Decision Uncertainty Distance in Fuzzy Multiple Criteria Decision Making Analysis. *International Journal of Mechanical and Industrial Engineering*, 16(3), 62 - 69.

[17] Ardil, C. (2021). Neutrosophic Multiple Criteria Decision Making Analysis Method for Selecting Stealth Fighter Aircraft. *International Journal of Aerospace and Mechanical Engineering*, 15(10), 459 - 463.

[18] Ardil, C. (2021). Military Combat Aircraft Selection Using Trapezoidal Fuzzy Numbers with the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). *International Journal of Computer and Information Engineering*, 15(12), 630 - 635.

[19] Ardil, C. (2021). Freighter Aircraft Selection Using Entropic Programming for Multiple Criteria Decision Making Analysis. *International Journal of Mathematical and Computational Sciences*, 15(12), 125 - 132.

[20] Ardil, C. (2021). Fighter Aircraft Evaluation and Selection Process Based on Triangular Fuzzy Numbers in Multiple Criteria Decision Making Analysis Using the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). *International Journal of Computer and Systems Engineering*, 15(12), 402 - 408.

[21] Ardil, C. (2021). Comparison of Composite Programming and Compromise Programming for Aircraft Selection Problem Using Multiple Criteria Decision Making Analysis Method. *International Journal of Aerospace and Mechanical Engineering*, 15(11), 479 - 485.

[22] Ardil, C. (2021). Advanced Jet Trainer and Light Attack Aircraft Selection Using Composite Programming in Multiple Criteria Decision Making Analysis Method. *International Journal of Aerospace and Mechanical Engineering*, 15(12), 486 - 491.

[23] Ardil, C. (2020). Trainer Aircraft Selection Using Preference Analysis for Reference Ideal Solution (PARIS). *International Journal of Aerospace and Mechanical Engineering*, 14(5), 195 - 209.

[24] Ardil, C. (2020). Regional Aircraft Selection Using Preference Analysis for Reference Ideal Solution (PARIS*). International Journal of Transport and Vehicle Engineering*, 14(9), 378 – 388.

[25] Ardil, C. (2020). Aircraft Selection Process Using Preference Analysis for Reference Ideal Solution (PARIS). *International Journal of Aerospace and Mechanical Engineering*, 14(3), 80 - 93.

[26] Ardil, C. (2020). A Comparative Analysis of Multiple Criteria Decision Making Analysis Methods for Strategic, Tactical, and Operational Decisions in Military Fighter Aircraft Selection. *International Journal of Aerospace and Mechanical Engineering*, 14(7), 275 - 288.

[27] Ardil, C. (2019). Military Fighter Aircraft Selection Using Multiplicative Multiple Criteria Decision Making Analysis Method. *International Journal of Mathematical and Computational Sciences*, 13(9), 184 - 193.

[28] Ardil, C. (2019). Fighter Aircraft Selection Using Technique for Order Preference by Similarity to Ideal Solution with Multiple Criteria Decision Making Analysis. *International Journal of Transport and Vehicle Engineering*, 13(10), 649 - 657.

[29] Ardil, C. (2019). Aircraft Selection Using Multiple Criteria Decision Making Analysis Method with Different Data Normalization Techniques. *International Journal of Industrial and Systems Engineering*, 13(12), 744 - 756.

[30] Ardil, C. , Pashaev, A. , Sadiqov, R. , Abdullayev, P. (2019). Multiple Criteria Decision Making Analysis for Selecting and Evaluating Fighter Aircraft. *International Journal of Transport and Vehicle Engineering*, 13(11), 683 - 694.