Neutrosophic Sets and Systems, Vol. 40, 2021
University of New Mexico

The Selection of LASER as Surgical Instrument in Medical using Neutrosophic Soft Set with Generalized Fuzzy TOPSIS, WSM and WPM along with MATLAB Coding

Muhammad Umer Farooq[1], Muhammad Saqlain[1*], Zaka-ur-Rehman[2]

[1] Department of Physics, Govt. Degree College Bhera, Sargodha, Pakistan. E-mail: umerfarooq900@gmail.com
[1*] School of Mathematics, Northwest University Xi'an 710127, China. msgondal0@gmail.com
[2] Department of Physics, University of Lahore, Sargodha Campus, Pakistan. E-mail: zakaurrehman52@gmail.com

Abstract: Lasers are medical devises and widely used in surgery to treat; diseased blood vessels, reduce blood loss, infection reduction, and many other purposes. Whereas, Lasers has many types based on the construction materials. Thus, the right selection of laser for surgery is very important to accomplish complex medical tasks. With the development of MCDM techniques and neutrosophic soft set, this problem can be solved with more accuracy and precision. The aim of this paper is to select the right type of laser for specific surgeries. To, select the right choice, six different laser types and seven criteria are taken. To find the best alternative, generalized TOPSIS, WSM, and WPM along with MATLAB coding techniques are used. Results are the same and showing the right selection of the same alternative which is already being used in the field of surgery. This shows that in the future, these techniques can be applied in the selection of medical equipment too.

Keywords: Accuracy Function, Fuzzy Soft Set, Neutrosophic Soft Set, MCDM, MATLAB, WSM, WPM, TOPSIS

---

1. Introduction

All anesthetists need to have fundamental information on laser material science and how laser radiation can associate with the careful condition, including the patient, sedative mechanical assembly and careful group. Lasers are finding expanding application in both medication and medical procedure and their utilization offers ascend to a few perils. The majority of these risks emerge as an immediate consequence of the idea of laser radiation. The role of laser as a safe, non-corrosive, non-toxic surgical tool in hospitals is very important. The approach of current century is to advance the medical technology and equipment as a result, the procedures become less invasive, and low cost for treatment. Due to this importance laser is in the spotlight.

The most commonly used type of laser (CO_2 laser) was designed by C. Kumar [1, 2], it has crossed many stages to become important tool in surgical instrument [2, 3]. The instrument designer, Uzi Sharon, was the person who joined the light emission noticeable (red) helium-neon laser with the undetectable light emission CO_2 laser. The gadget from the mid-1970s was outfitted with the necessities of clinical medical procedure [4]. Isaac Kaplan is famous for "father of laser medical procedure" who created various laser-careful procedures that assisted with characterizing new fundamental conditions in plastic and reconstructive medical procedure [5].

In current century, laser treatments have a bigger number; major surgeries, skin care, ENT procedures, gall bladder removal procedure and many more [6, 7]. Additionally, lasers made a difference to build up another interventional method also to traditional medical procedure, the supposed in situ coagulation which can be performed cursorily, interstitially or intravascularly [8, 9, 10]. In this issue of Photonics and Lasers in Medicine, Philipp et al. [11] present information of 450 patients determined to have pyogenic granuloma who were dealt with utilizing the Nd: YAG laser (1064 nm) in impression strategy or on the other hand by direct coagulation. The outcomes mirror the significant skills of this division in applying the in-situ coagulation, guaranteeing not just supported helpful achievement yet in addition an incredible corrective result.

With the development of fuzzy sets [12] decision making becomes easier but later on this theory was extended by [13] named as Intuitionistic fuzzy number theory. To deal with more precision, accuracy and indeterminacy this idea was extended by [14] called as neutrosophy theory. To, discuss the applications of these theory number of developments were made but the most important one is the theory of soft set [15]. Later on, fuzzy, intuitionist and neutrosophy theories were extended to fuzzy softset [16], intuitionistic soft set [17] and neutrosophic soft set [18]. In different fields the applications of these theories are presented by many researchers [19-26], but with the development of TOPSIS, WSM and WPM techniques [27-32] it becomes more powerful tool to solve the MCDM problems [33-38]. Many other novel works under neutrosophic environment are done along with real life applications [43-46]. In object selection, neutrosophic sets are widely used for accuracy [47-49].

Now the question arises why we are using these techniques in this case study? To get the answer of this question, firstly you need to know the attribute and alternatives; since laser are of many types having different properties which makes it a perfect problem to apply the above-mentioned MCDM techniques. The neutrosophic theory is used for more accuracy thus the techniques to solve MCDM problems under neutrosophic environment can be applied.

1.1 Contribution / Motivation

LASER is widely used in all over the fields of sciences, especially in the field of medicine LASERS play revolutionary role. There are many kinds used in medical field for various surgeons, in surgery LASERS are used to cut deeply and cauterize. Producing precise and accurate surgical cut. Ablate tissues and cells from the surface. Internal surgery of patients without visible wound. To evaporate the damaged cells, there are countless uses of LASER in medical field.

In this research five construction-based types of LASERS are being discussed and we are finding which type is more efficient and accurate in the surgical field using mathematical tools along with the use of MATLAB.

1.2 The paper presentation

The layout of this research is presented in Figure:1. Section 1, consists of introduction of the topic, literature review and the motivation along with contribution. Section 2, preliminaries are presented in this section. In third section, algorithms of TOPSIS, WSM and WPM are listed along with flowcharts. In section 5, the case study of LASER selection is done using TOPSIS algorithm and in section 6, the case study is solved with the help of WSM and WPM using MATLAB code. Finally, result discussion is done and the present research is concluded with future directions.

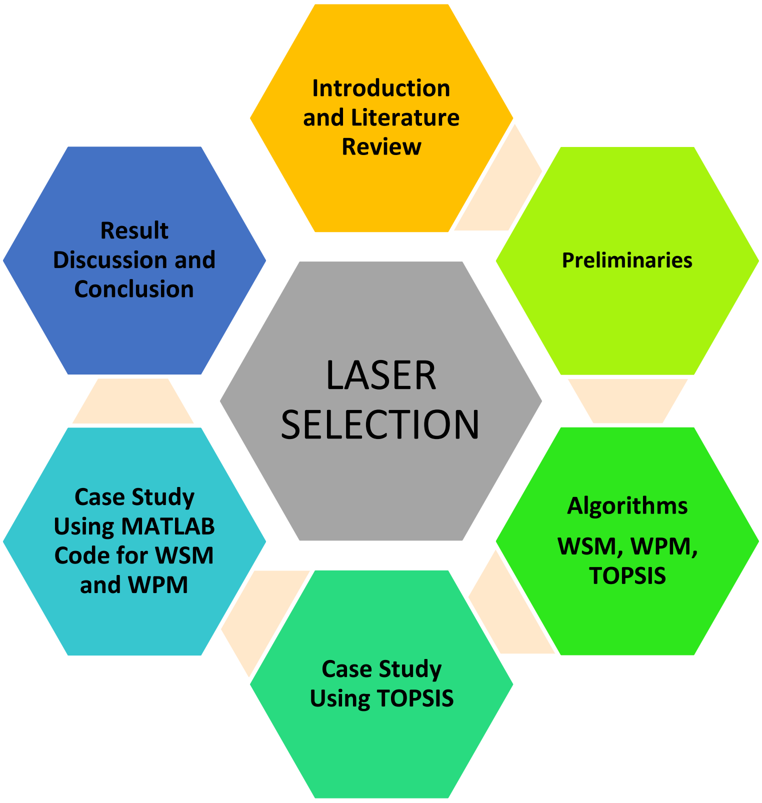

Figure 1: The layout of the paper

2.Preliminaries

Definition 2.1: Linguistic Set [39]

Let A= $\{a_0, a_1, a_2, \dots, a_n\}$ be finite and fully ordered set of discrete terms where $n \in N$.

Example: Let us consider a set A= $\{a_1, a_2, \dots, a_5\}$ every element representing a specific linguistic term value, which are as; *"None", "low effective", "moderate effective", "effective", "high effective"*

Definition 2.2: Fuzzy Set [12]

In fuzzy set, an element "∂" is assigned a degree of membership from [0,1]. Mathematically, represented as $\mu_\partial \in [0,1]$.

Definition 2.3: Neutrosophic Set [14]

Let τ be an initial universal set and E be a set of parameters. Let's consider, A$\subset$ E. Let P(τ) represents the set of all neutrosophic sets over τ, where F is a mapping given by

$$F: A \longrightarrow P(\tau)$$

Definition 2.4: MCDM [42]

Multi-criteria decision makings are very complex. To find out the best option MCDM techniques are used like, TOPSIS, VIKOR, AHP, ELECTREE, WSM, WPM, etc.

Definition 2.5: Accuracy Function [41]

The process /mathematical form of conversion of neutrosophic numbers N into crisp numbers is said to be accuracy function.

$$A(N) = \frac{[T(x) + I(x) + F(x)]}{3} : x \epsilon N$$

Definition 2.6: TOPSIS [33]

TOPSIS is an acronym that stands for 'Technique of Order Preference Similarity to the Ideal Solution' and is a pretty straight forward MCDA method. As the name implies, the method is based on finding an ideal and an anti-ideal solution and comparing the distance of each one of the alternatives to those.

Definition 2.7: LASER [1]

Laser stands for light amplification by stimulated emission of radiation, A laser is a physical device that radiate light through a process of optical amplification via stimulated emission of electromagnetic radiation.

3. Algorithms

In this section three algorithm are presented to solve MCDM problem under neutrosophic environment.

3.1 Generalized Fuzzy TOPSIS Algorithm

The TOPSIS technique [33] is mainly used for the ranking of alternatives in MCDM and MAGDM problems. In this method crisp/fuzzy/intuitionistic numbers were used to select the best alternative. Thus, technique of TOPSIS was extended for the Neutrosophic environment and said to be Generalized Fuzzy TOPSIS. The stepwise algorithm of generalized fuzzy TOPSIS is presented in Figure: 2.

Step: 1 Consideration of problem.

Step: 2 The formulation and assumptions of the problem.

Step: 3 Construction of linguistic decision matrix.

Step: 4 Assigning of neutrosophic numbers (NN's) to each linguistic value.

Step: 5 Conversion of neutrosophic numbers into crisp using accuracy function.

Step: 6 Now apply TOPSIS algorithm. (Presented below)

TOPSIS Algorithm {**Step 1:** Construct the Normalized Decision Matrix to transform the various attribute dimensions into non-dimensional attributes, which allows comparison across the attributes.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

Step 2: Construct the Weighted Normalized Decision Matrix.

Assume we have a set of weights for each criteria w_j for j = 1, 2, 3…n. Multiply each column of the normalized decision matrix r_{ij} by its associated weight. An element of the new matrix is:

$$V_{ij} = w_j \, r_{ij}$$

Step 3: Determine Ideal and Negative-Ideal Solutions, A⁺ = { $V_1, \ldots, V_n$}, where

V_j^+ = {max (V_{ij}) if j ∈ J; min (V_{ij}) if j ∈ J^+}

J^+ Associated with the criteria having a positive impact.

A^- = { $V_1, \ldots, V_n$}, where V_j^- = {min (V_{ij}) if j ∈ J; max (V_{ij}) if j ∈ J^-}

J^- Associated with the criteria having a negative impact.

Step 4: Calculate the Separation Measure:

- Ideal Separation

$$S_i^+ = \sqrt{\sum_{j=1}^{n}(V_{ij} - V_j^+)^2} \qquad i = 1,2,3,\ldots,m$$

- Negative Ideal Separation

$$S_i^- = \sqrt{\sum_{j=1}^{n}(V_{ij} - V_j^-)^2} \qquad i = 1,2,3,\ldots,m$$

Step 5: Calculate the Relative Closeness to the Ideal Solution

$$C_i^* = \frac{S_i^-}{(S_i^+ + S_i^-)}, \quad 0 < C_i^* < 1, \qquad i = 1,2,3,\ldots,m \ .$$

$$C_i^* = 1, \qquad if\ A_i = A^+$$

$$C_i^* = 0, \qquad if\ A_i = A^-$$

Step 6: Rank the preference order a set of alternatives can now be preference ranked according to the descending order of C_i^* } *End of TOPSIS algorithm*.

Step: 7 Rank the alternatives.

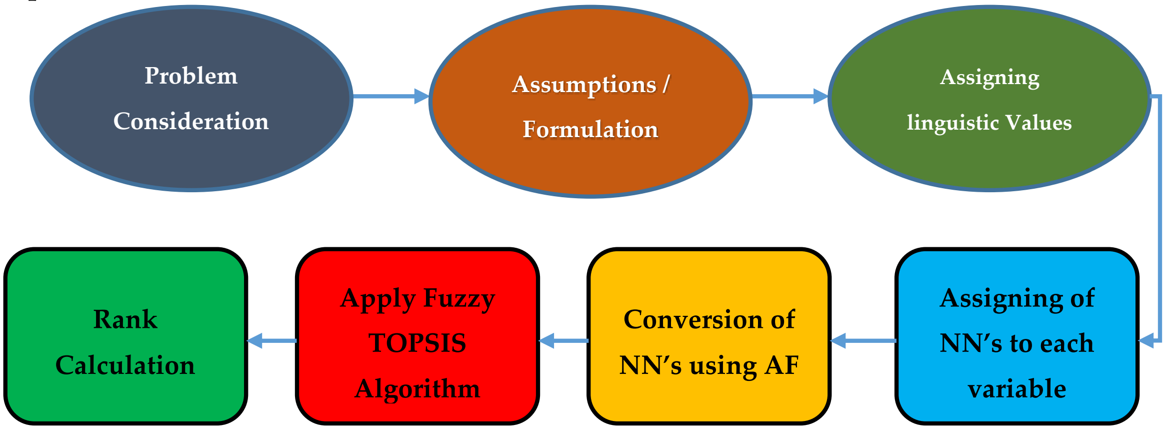

Figure 2: Flowchart for generalized fuzzy TOPSIS

3.2 Weighted Sum Model (WSM) Algorithm [27]

The WSM is commonly used for single dimensional problems. In this method the weighted sum performance rating of each alternative is calculated using the algorithm. The stepwise procedure is shown in Figure 3;

Step 1: Construction of decision matrix M from the given problem.

Step 2: Construction of normalized decision matrix $\Re = [r_{kj}]_{m\times n} k = 1,2,3, \ldots, m \; and \; j = 1,2,3, \ldots, n$

Step 3: Construction of weighted normalized decision matrix $\wp = [w_j r_{kj}]_{m\times n} \; and \; \sum_{j=1}^{n} w_j = 1$

Step 4: Calculation of S_k^{WSM} ; $k = 1,2,3, \ldots, m$ score of each alternative.

$$S_k^{WSM} = \sum_{j=1}^{n} w_j r_{kj} \; ; k = 1,2,3, \ldots, m \; and \; j = 1,2,3, \ldots, n$$

Step 5: Selection of best alternative i.e. $max\,(S_k^{WSM} \; ; k = 1,2,3, \ldots, m)$

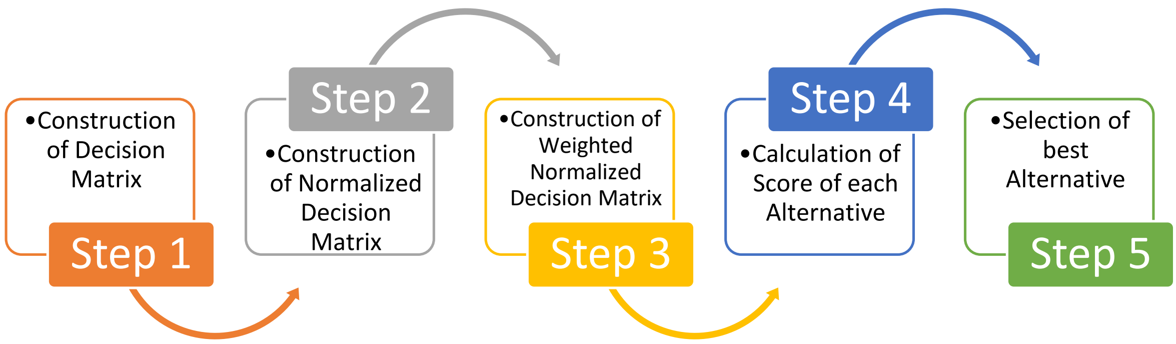

Figure 3: Flowchart for WSM algorithm

3.3 Weighted Product Model (WPM) Algorithm [29]

The WPM is mainly used to find best alternative in MCDM problems. In this method the alternatives are simplified by multiplying a number of ratios of each criterion. This method is some time known as dimensionless analysis. The stepwise procedure is shown in Figure 4;

Step 1: Construction of decision matrix $\mathcal{M}$ from the given problem.

Step 2: Construction of normalized decision matrix $\mathbb{R} = [r_{kj}]_{m\times n} k = 1,2,3, \ldots, m \; and \; j = 1,2,3, \ldots, n$

Step 3: Construction of weighted normalized decision matrix $\mathbb{N} = [{r_{kj}}^{w_j}]_{m\times n} \; and \; \sum_{j=1}^{n} w_j = 1$

Step 4: Calculation of S_k^{WPM} ; $k = 1,2,3, \ldots, m$ score of each alternative.

$$S_k^{WSM} = \prod_{j=1}^{n} {r_{kj}}^{w_j} \; ; k = 1,2,3, \ldots, m \; and \; j = 1,2,3, \ldots, n$$

Step 5: Selection of best alternative i.e. $max\,(S_k^{WPM} \; ; k = 1,2,3, \ldots, m)$

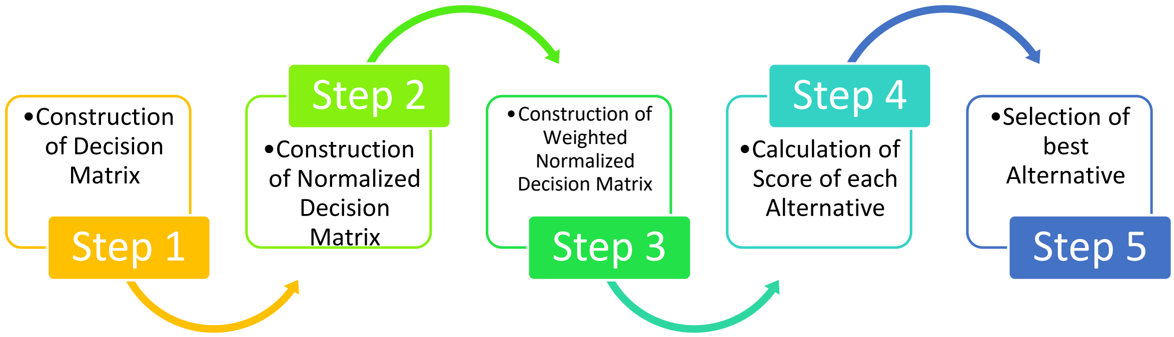

Figure 4: Flowchart for WPM algorithm

4: Case Study

In this section a case study of LASER selection for the surgery in medical is considered and the selection is made by applying all the above-mentioned algorithms.

4.1 Problem Formulation

LASERS are widely used in all over the fields of sciences, especially in the field of medicine and surgery. In surgery, LASERS are used to cut deeply and cauterize. Producing precise and accurate surgical cut. Ablate tissues and cells from the surface. Internal surgery of patients without visible wound. To evaporate the damaged cells, there are countless uses of LASER in medical field.

4.2 Parameters

Selection is a complex issue, to resolve this problem criteria and alternative plays an important role. Following criteria and alternatives are considered in this problem formulation.

Criteria's of Each Laser						
C_1 Construction Type	C_2 Wavelength	C_3 Frequency	C_4 Delivery System	C_5 Medium	C_6 Pumping Method	C_7 Interaction

Lasers as Alternatives					
L_1	L_2	L_3	L_4	L_5	L_6
Argon	KTP	Helium Neon	YAG	YSGG	Diode

4.3 Assumptions

Consider $K = \{\kappa_1, \kappa_2, \kappa_3, \kappa_4\}$ decision makers who will assign linguistic values from Table .1 according to his own interest, knowledge and experience, to the above-mentioned criteria and alternatives and shown in Table.2.

Sr # No	Linguistic variable	Code	Neutrosophic Number
1	None	N	(0.0, 0.1,0.5)
2	Low Effective	LE	(0.2,0.4,0.8)
3	Moderate Effective	ME	(0.4,0.2,0.5)

4	Effective	E	(0.6,0.2,0.3)
5	High Effective	HE	(1.0,0.0,0.1)

Table 1: Linguistic variables, codes and neutrosophic numbers

4.4 Application of Proposed Generalized Fuzzy TOPSIS Algorithm

Step 1: Presented in section 4.1

Step 2: Presented in section 4.2 and 4.3.

Step 3: Assigning linguistic variables to each alternatives and criteria's / attributes.

	Strategies	κ_1	κ_2	κ_3	κ_4
C_1= Construction Type	L_1	N	ME	E	ME
	L_2	LE	E	HE	E
	L_3	ME	HE	N	HE
	L_4	E	ME	N	N
	L_5	HE	N	LE	LE
	L_6	N	LE	ME	ME
C_2= Wavelength	L_1	LE	ME	E	E
	L_2	ME	E	HE	HE
	L_3	E	HE	N	ME
	L_4	HE	ME	LE	E
	L_5	N	E	ME	HE
	L_6	LE	HE	E	ME
C_3= Frequency	L_1	ME	N	HE	E
	L_2	E	LE	ME	HE
	L_3	HE	ME	E	N
	L_4	ME	E	HE	LE
	L_5	E	HE	LE	ME
	L_6	HE	ME	E	N
C_4= Delivery System	L_1	N	E	HE	LE
	L_2	LE	HE	N	E
	L_3	ME	E	E	HE
	L_4	E	HE	N	LE
	L_5	HE	N	LE	E
	L_6	N	ME	LE	ME
C_5=Medium	L_1	LE	E	E	E
	L_2	ME	HE	LE	HE
	L_3	E	ME	HE	N

	L_4	HE	E	LE	HE
	L_5	ME	HE	E	N
	L_6	HE	N	LE	E
C_6= Pumping Method	L_1	LE	E	E	E
	L_2	ME	HE	LE	HE
	L_3	E	ME	HE	N
	L_4	HE	E	LE	HE
	L_5	ME	HE	E	N
	L_6	HE	N	LE	E
C_7= Interaction	L_1	LE	E	E	E
	L_2	ME	HE	LE	HE
	L_3	E	ME	HE	N
	L_4	HE	E	LE	HE
	L_5	ME	HE	E	N
	L_6	HE	N	LE	E

Table 2: Each decision maker, will assign linguistic values to each attribute, from Table .1

Step 4: Substitution of neutrosophic numbers (NNs) to each linguistic variable.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
L_1	(0.0, 0.1,0.5)	(1.0, 0.0, 0.1)	(0.6, 0.2,0.3)	(0.6, 0.2,0.3)	(0.4, 0.2,0.5)	(0.0, 0.1,0.5)	(0.6, 0.2,0.3)
L_2	(0.2, 0.4,0.8)	(0.4, 0.2,0.5)	(0.0, 0.1,0.5)	(1.0, 0.0, 0.1)	(0.6, 0.2,0.3)	(0.2, 0.4,0.8)	(0.0, 0.1,0.5)
L_3	(0.4, 0.2,0.5)	(0.0, 0.1,0.5)	(0.2, 0.4,0.8)	(1.0, 0.0, 0.1)	(0.6, 0.2,0.3)	(0.4, 0.2,0.5)	(1.0, 0.0, 0.1)
L_4	(0.6, 0.2,0.3)	(1.0, 0.0, 0.1)	(0.4, 0.2,0.5)	(0.2, 0.4,0.8)	(1.0, 0.0, 0.1)	(0.6, 0.2,0.3)	(0.0, 0.1,0.5)
L_5	(1.0, 0.0, 0.1)	(0.2, 0.4,0.8)	(0.6, 0.2,0.3)	(0.4, 0.2,0.5)	(0.0, 0.1,0.5)	(1.0, 0.0, 0.1)	(0.4, 0.2,0.5)

L_6	(0.4, 0.2,0.5)	(0.0, 0.1,0.5)	(1.0, 0.0, 0.1)	(0.6, 0.2,0.3)	(0.0, 0.1,0.5)	(0.4, 0.2,0.5)	(0.6, 0.2,0.3)

Table: 3 Assign neutrosophic number to each linguistic value from table 1.

Step 5: Conversion of fuzzy neutrosophic numbers NNs of step 4, into fuzzy numbers by using accuracy function.

$$A(F) = \{ x = \frac{[T_x + I_x + F_x]}{3} \}$$

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
L_1	0.200	0.366	0.366	0.366	0.366	0.200	0.366
L_2	0.400	0.366	0.200	0.366	0.366	0.466	0.200
L_3	0.366	0.200	0.466	0.366	0.366	0.366	0.3666
L_4	0.366	0.366	0.366	0.466	0.366	0.366	0.200
L_5	0.366	0.466	0.366	0.366	0.200	0.366	0.366
L_6	0.366	0.200	0.366	0.366	0.200	0.366	0.366

Table: 4 After applied accuracy function the obtain result converted into fuzzy value

Step 6: Now we apply algorithm of TOPSIS to obtain relative closeness.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
L_1	0.2	0.1	0.1	0.1	0	0.266	0.0006
L_2	0	0.1	0.266	0.1	0	0	0.1666
L_3	0.034	0.266	0	0.1	0	0.1	0
L_4	0.034	0.1	0.1	0	0	0.1	0.1666
L_5	0.034	0	0.1	0.1	0.166	0.1	0.0006
L_6	0.034	0.266	0.1	0.1	0.166	0.1	0.0006

Table: 5 Normalized decision matrices

Step 6.1: Calculation of weighted normalized matrix

weights	0.1	0.3	0.1	0.1	0.1	0.1	0.2
	C_1	C_2	C_3	C_4	C_5	C_6	C_7

L_1	0.2	0.1	0.1	0.1	0	0.266	0.0006
L_2	0	0.1	0.266	0.1	0	0	0.1666
L_3	0.034	0.266	0	0.1	0	0.1	0
L_4	0.034	0.1	0.1	0	0	0.1	0.1666
L_5	0.034	0	0.1	0.1	0.166	0.1	0.0006
L_6	0.034	0.266	0.1	0.1	0.166	0.1	0.0006

Table: 5 Weighted normalized decision matrices

Step 6.2: Calculation of the ideal best and ideal worst value,

v_j^+ =Indicates the ideal (best)

v_j^- = Indicates the ideal (worst)

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
L_1	0.094677	0.072439	0.030048	0.044721	0	0.079928	0.000509
L_2	0	0.072439	0.079928	0.044721	0	0	0.14142
L_3	0.016095	0.192688	0	0.044721	0	0.030048	0
L_4	0.016095	0.072439	0.030048	0	0	0.030048	0.14142
L_5	0.016095	0	0.030048	0.044721	0.070711	0.030048	0.000509
L_6	0.016095	0.192688	0.030048	0.044721	0.070711	0.030048	0.000509
v_j^+	0.211244	0.41414	0.3328	0.223607	0.234759	0.3328	0.23561
v_j^-	0.094677	0.192688	0.079928	0.044721	0.070711	0.079928	0.14142

Table: 6 Ideal worst and Ideal best values

Step 7: Calculation of rank.

$$p_i = \frac{s_{ij}^-}{s_{ij}^+ + s_{ij}^-}$$

	s_j^+	s_j^-	$p_i = \frac{s_{ij}^-}{s_{ij}^+ + s_{ij}^-}$	Rank
L_1	0.130184	0.130821	0.501	3
L_2	0.153048	0.116773	0.433	4
L_3	0.112088	0.198464	0.639	2

L_4	0.158502	0.080059	0.336	5
L_5	0.213991	0.056231	0.208	6
L_6	0.093076	0.200726	0.683	1

Table: 7 Calculation of rank by relative closeness

5. Case Study using WSM and WPM MATLAB Code [43]

To run the WSM and WPM MATLAB code for the case study, the variable used in coding are defined by;

X: this is defined as decision matrix and presented in Table: 4.

W: this is defined as weight of each attribute and presented in Table: 5.

Wcriteria: < (0,1,1,0,0,0,0) >

$\boldsymbol{i} = 1,2,3,4,5,6 \ \ and \ \boldsymbol{j} = 1,2,3,4,5,6,7$

MATLAB COMMAND

```
Xval=length(X(:,1));
for i=1:Xval
for j= 1:length(W)
if Wcriteria(1,j)== 0
Y(i,j)=min(X(:,j))/X(i,j);
else
Y(i,j)=X(i,j)/max(X(:,j));
end
end
end
for i=1:Xval
PWSM(i,1)=sum(Y(i,:).*W);
PWPM(i,1)=prod(Y(i,:).^W);
End
```

Results

Preference score of WSM = < (0.65641, 0.70442, 0.809, 0.72181, 0.66273, 0.83398) >

Preference score of WPM = < (0.63378, 0.66305, 0.77807, 0.69813, 0.62619, 0.80708) >

6. Result Discussion

To check the validity or applicability of algorithms in neutrosophic soft set and MCDM environment the case study of Laser selection is considered in which six lasers are considered based on the construction material. Firstly, using the generalized neutrosophic TOPSIS technique the ranking of alternatives is calculated. Secondly, WSM and WPM techniques are applied using MATLAB code to calculate the rank. In these calculations, the ranking of each laser with respect to each criterion is calculated which are shown in Table 8 and Figure 5. Result shows that the above-mentioned techniques can be used to rank medical equipment too.

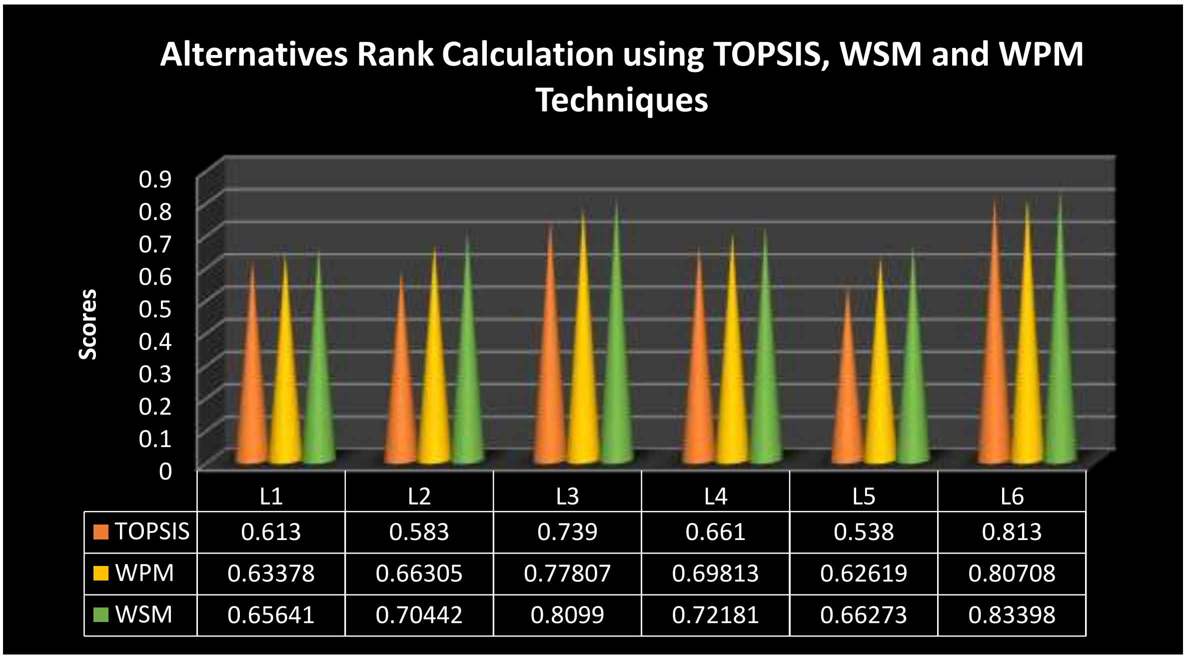

Figure 5: Ranking comparison of alternatives

Graphical and tabular comparison is presented in Table 8 and in Figure 5, which shows that under TOPSIS, WSM and WPM technique *L6* is best alternative whereas, *L5* is the worst selection respectively.

Alternative	TOPSIS	WPM	WSM
L1	0.613	0.63378	0.65641
L2	0.583	0.66305	0.70442
L3	0.739	0.77807	0.8099
L4	0.661	0.69813	0.72181
L5	0.538	0.62619	0.66273
L6	0.813	0.80708	0.83398

Table: 8 Alternatives rank comparison using WSM, WPM and TOPSIS

5. Conclusions

Lasers are medical devices that used a precisely focused beam of lights to treat or remove tissues or blood vessels etc. Based on construction material, lasers are divided into five main categories which also have different parameters and attributes. Thus, considering it as a case study, MCDM techniques are applied in the neutrosophic soft set environment. The results calculated using WSM, WPM and TOPSIS are the same. The lasers which are being used in medical filed for the surgery already have the same ranks. This shows that this technique is very helpful to rank the medical equipment in the future with more accuracy and precision.

This work can't be compared; as no one has applied these techniques to rank laser in medical surgery. In our forthcoming work, we will provide more application of these techniques in medical filed like nebulizer, infusion pumps and suction devices etc. In future, this study can be used in some more medical equipment selection.

Conflicts of Interest

The authors declare no conflict of interest.

Reference:

[1] Patel CKN. Interpretation of CO2 optical maser experiments. Phys Rev Lett 1964; 12:588. Erratum in Phys Rev Lett 1964; 12:684.

[2] Rao MC. Applications of CO_2 laser in medicine. IJAPBC 2013;2(3):501–6.

[3] Ha RY, Burns JL, Hoopman JE, Burns AJ. Lasers in plastic surgery.SRPS 2003;9(40):1–27.

[4] Kaplan I, Sharon U. Current laser surgery. Ann N Y Acad Sci 1976; 267:247–53.

[5] Kaplan I. The role of the CO_2 laser in surgery. Med Laser Appl, 2010; 25(1):3–4.

[6] Eichler J, Gonçalves O. A review of different lasers in endonasal surgery: Ar-, KTP-, dye-, diode-, Nd-, Ho- and CO2-laser. Med Laser Appl 2002;17(3):190–200.

[7] Wendt-Nordahl G, Michel MS, Alken P, Häcker A. Laser surgery around the prostate – Experience from a live surgery symposium in Mannheim. Med Laser Appl 2007;22(3):207–10.

[8] Philipp C, Berlien HP, Waldschmidt J. Lasers in pediatric surgery:a review. J Clin Laser Med Surg. 1991;9(3):189–94.

[9] Philipp CM, Rohde E, Berlien HP. Nd:YAG laser procedures in tumor treatment. Semin Surg Oncol 1995;11(4):290–8.

[10] Algermissen B, Philipp CM, Müller U, Urban P, Berlien H-P.Interstitial thermotherapy (ITT) using Nd:YAG laser as a new option for the treatment of neuroma. Med Laser Appl 2001;16(2):129–34.

[11] Philipp CM, Almohamad A, Adam M, Becker-Köhnlein J,Berlien HP, Müller U, Poetke M, Urban P. Pyogenic granuloma – Nd:YAG laser treatment in 450 patients. Photon Lasers Med 2015;4(3):215–26.

[12] Zadeh, L. A "Fuzzy sets", Inform and Control, 8(3), pp. 338-353, 1965.

[13] Atanassov, K. T, "Intuitionistic fuzzy sets. Fuzzy Sets and Systems", 20(1), pp. 87-96, 1986.

[14] F. Smarandache, (1998). Neutrosophy. Neutrosophic probability, set, and logic. ProQuest Information & Learning, Ann Arbor, Michigan, USA.

[15] Molodtsov, D. "Soft set theory-First results, Computers and mathematics with applications", 37, pp.19-31, 1999.

[16] Maji, Pabitra & Biswas, R. & Roy, A.R. (2001). Fuzzy soft sets. 9. 589-602.

[17] Maji, Pabitra & Biswas, Ranjit & Roy, Akhil. (2001). Intuitionistic fuzzy soft sets. The Journal of Fuzzy Mathematics. 9.

[18] P. K. Maji, (2013), Neutrosophic soft set, *Annals of Fuzzy Mathematics and Informatics*, 5(1) 157-168.

[19] Wielki, Janusz and Jurczyk, Magdalena and Madera, Dariusz. (2019). Application of TOPSIS Method for Evaluation of IT Application in the Hospital. 10.34190/KM.19.134.

[20] Abdel-Baset, M., Chang, V., & Gamal, A. (2019). Evaluation of the green supply chain management practices: A novel neutrosophic approach. Computers in Industry, 108, 210-220.

[21] Abdel-Basset, M., Saleh, M., Gamal, A., & Smarandache, F. (2019). An approach of TOPSIS technique for developing supplier selection with group decision making under type-2 neutrosophic number. Applied Soft Computing, 77, 438-452.

[22] Abdel-Basset, M., Atef, A., & Smarandache, F. (2019). A hybrid Neutrosophic multiple criteria group decision making approach for project selection. Cognitive Systems Research,

[23] M. Abdel-Basset, M. Mohamed, Y. Zhou, I. Hezam, (2017). Multi-criteria group decision making based on the neutrosophic analytic hierarchy process. Journal of Intelligent & Fuzzy Systems, 33(6): 4055-4066.

[24] M. Riaz, K. Naeem and M. O. Ahmad, Novel Concepts of Soft Sets with Applications, Annals of Fuzzy Mathematics and Informatics 13, No. 2 (2017) 239-251.

[25] M. Saqlain, N. Jafar, M. Rashid and A. Shahzad, Prediction of Cricket World Cup 2019 by TOPSIS Technique of MCDM-A Mathematical Analysis, International Journal of Scientific & Engineering Research 10, No. 2 (2019) 789-792.

[26] M. Saqlain, M. N. Jafar, M. Riaz, A New Approach of Neutrosophic Soft Set with Generalized Fuzzy TOPSIS in Application of Smart Phone Selection, Neutrosophic Sets and Systems 32 (2020) 307-316 2020. https://doi.org/10.5281/zenodo.3723161

[27] Adriyendi (2015) Multi-attribute decision making using simple additive weighting and weighted product in food choice. International Journal of Information Engineering and Electronic Business, 6, 8–14.

[28] Calvo-Flores, Miguel & Verdegay, Jose & Vila, M. (1992). Linguistic decision-making models. International Journal of Intelligent Systems. 7. 479 - 492. 10.1002/int.4550070507.

[29] Afshari, A. R., & Mojahed, M. (2010). Simple additive weighting approach to personnel selection problem. International Journal of Innovation and Technology Management, 1(5), 511–515.

[30] Adriyendi (2015). Multi-attribute decision making using simple additive weighting and weighted product in food choice. I.J. Information Engineering and Electronic Business, 6, 8–14.

[31] Lazim, A., & Rabiatul, A. C. W. (2014). Simple additive weighting methods of multi criteria decision making and applications: A decade review. International Journal of Information Processing and Management (IJIPM), 1(5), 39–49.

[32] C. Hwang, K. Yoon, Multiple Attribute Decision Making: Methods and Applications, A State-of-the-Art Survey, Springer (1981).

[33] Hwang, C.L.; Yoon, K. (1981). Multiple Attribute Decision Making: Methods and Applications. New York: Springer-Verlag.

[34] M. Saqlain, N. Jafar, A. Riffat, Smart Phone Selection by Consumers' İn Pakistan: FMCGDM Fuzzy Multiple Criteria Group Decision Making Approach, Gomal University Journal of Research 34(1) (2018) 27-31.

[35] F. E. Boran, S. Genç, M. Kurt, D. Akay, A Multi-Criteria Intuitionistic Fuzzy Group Decision Making for Supplier Selection with TOPSIS Method, Expert System and Applications 36(8) (2009) 11363-11368.

[36] Chourabi, Zouhour & Khedher, Faouzi & Dhouib, Amel & Cheikhrouhou, Morched. (2018). Multi-criteria decision making in workforce choice using AHP, WSM and WPM. The Journal of The Textile Institute. 110. 1-10. 10.1080/00405000.2018.1541434.

[37] S. Broumi, F. Smarandache, Intuitionistic Fuzzy Soft Expert Sets and its Application in Decision Making, Journal of New Theory (1) (2015) 89-105.

[38] Zulqarnain, Rana Muhammad & Saeed, Muhammad & Ahmad, Nadeem & Dayan, Fazal & Ahmad, Bilal. (2020). Application of TOPSIS Method for Decision Making. 7. 76-81.

[39] Abdel-Basset, M., Manogaran, G., Gamal, A., & Smarandache, F. (2019). A group decision making framework based on neutrosophic TOPSIS approach for smart medical device selection. Journal of medical systems, 43(2), 38.

[40] Calvo-Flores, Miguel & Verdegay, Jose and Vila, M. (1992). Linguistic decision-making models. International Journal of Intelligent Systems. 7. 479 - 492. 10.1002/int.4550070507.

[41] Şahin, R. (2014). Multi-criteria neutrosophic decision making method based on score and accuracy functions under neutrosophic environment. arXiv preprint arXiv:1412.5202.

[42] Belton, Valerie and Stewart, Theodor. (2002). Multiple Criteria Decision Analysis: An Integrated Approach. 10.1007/978-1-4615-1495-4.

[43] Saqlain, M., Muhammad Saqlain and Mehmood A. (2020). Application of Similarity Measure on m-polar Interval-valued Neutrosophic Set in Decision Making in Sports, *Neutrosophic Sets and Systems*, vol. 38, 2020, pp. 317-334. DOI: 10.5281/zenodo.4300518

[44] Saqlain, M., Jafar, M. N., Riaz, M. (2020). A New Approach of Neutrosophic Soft Set with Generalized Fuzzy TOPSIS in Application of Smart Phone Selection, *Neutrosophic Sets and Systems*, **32**, pp. 307-316, 2020. DOI: 10.5281/zenodo.3723161

[45] Riaz M., Saqlain M. and Saeed M. (2019). Application of Generalized Fuzzy TOPSIS in Decision Making for Neutrosophic Soft set to Predict the Champion of FIFA 2018: A Mathematical Analysis, *Punjab University Journal of Mathematics,* **51(8**): 111-126.

[46] Amalini. L. N. Kamal. M., Abdullah. L. and Saqlain. M. (2020). Multi-Valued Interval Neutrosophic Linguistic Soft Set Theory and Its Application in Knowledge Management, *IET CAAI Transactions on Intelligence Technology, 1-13.*

[47] A. Nabeeh, F. Smarandache, M. Abdel-Basset, H. A. El-Ghareeb, A. Aboelfetouh. (2019). An Integrated Neutrosophic-TOPSIS Approach and its Application to Personnel Selection: A New Trend in Brain Processing and Analysis. *IEEE Access*, doi: 10.1109/ACCESS.2019.2899841

[48] A. Nabeeh, M. Abdel-Basset, H. A. El-Ghareeb, A. Aboelfetouh. (2019). Neutrosophic Multi-Criteria Decision-Making Approach for IoT-Based Enterprises. *IEEE Access*, doi: 10.1109/ACCESS.2019.2908919

[49] Abdel-Basset, M., Manogaran, G., Mohamed, M., and Chilamkurti, N. (2018). Three-way decisions based on neutrosophic sets and AHP-QFD framework for supplier selection problem. *Future Generation Computer Systems*, 89, 19-30.

Received: Sep 11, 2020. Accepted: Feb 9, 2021