



Multicriteria Decision-Making Applications Based on Generalized Hamming Measure for Law

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Abstract

Jurisprudential decisions always reflect confidence in the law. The more wrong a judge's decision is, the greater the reaction will be. This is something we all know. But today, the reactions to the decisions of the judges are increasing in a negative way. Because, making so many conscientious decisions or transferring cases to higher courts have widely increased. This means that people's objections to the decisions increase. To avoid such problems in judges' decisions, an algorithm is introduced in this article. The mentioned algorithm shows every decision given by judges as generalized set-valued neutrosophic quadruples and calculates its similarity to the ideal decision by Hamming similarity measure on generalized set-valued neutrosophic quadruples. The algorithm is introduced in such a way that it decides whether the decision to be made in each case is similar to the decision made by the judge or not. This allows us to see how correct the judges' decisions are. The closer the algorithm result is to 1, the more accurate the decision. You can judge decisions according to this accuracy value and it is aimed to reduce the problems such as objections to the decisions.

Keywords: generalized set valued neutrosophic quadruple numbers, generalized Hamming similarity measure, law, decision making

1. Introduction

Smarandache [1] defined neutrosophic logic and neutrosophic sets in 1998. In neutrosophic logic and sets, there exist a degree of membership T , indeterminacy I and a degree of non-membership (falsity) F . These are defined independently of each other. Thus, a lot of researchers studied neutrosophic theory [2-10]. Recently, Şahin et al. [11] introduced neutrosophic triplet bipolar metric space; Aslan et al. [12] obtained neutrosophic modeling of Talcott

Parsons's action and decision-making applications; Şahin and Kargin [13] introduced neutrosophic triplet v-generalized metric space, Tripathy and Das, S. [14] obtained pairwise neutrosophic b-continuous function in neutrosophic Bitopological Spaces; Kargin et al. [15] introduced neutrosophic triplet m-Banach space.

In 2015, Smarandache [16] defined neutrosophic quadruple set and neutrosophic quadruple number. Neutrosophic quadruple sets are generalized neutrosophic sets and a neutrosophic quadruple set is shown as $\{(x, yT, zI, tF): x, y, z, t \in \mathbb{R} \text{ or } \mathbb{C}\}$ where x is called the known part, (yT, zI, tF) is called the unknown part, and T, I, F are the usual neutrosophic logic tools. Thus, a lot of researchers studied neutrosophic quadruple structures [16-23]. Recently, Kargin et al. [24] obtained generalized Hamming similarity measure based on neutrosophic quadruple numbers; Şahin et al. [25] introduced Hausdorff measures on generalized set valued neutrosophic quadruple numbers; Mohseni and Jun [26] studied commutative neutrosophic quadruple ideals of neutrosophic quadruple BCK-algebras; Şahin et al. [27] obtained generalized neutrosophic quadruple sets and numbers; Borzooei et al. [28] introduced positive implicative neutrosophic quadruple BCK-algebras and ideals; Ibrahim et al. [29] studied neutrosophic quadruple hypervector spaces.

Neutrosophic structures are defined to deal with an ever-present state of uncertainty. New structures have been introduced in order to eliminate these uncertain situations in every area. One of the areas where vagueness is experienced is law. Decisions made by judges involve more serious problems day by day. Most researchers have studied ways in order to make it easier for judges in making their decisions. However, the objections to the decisions of the judges are increasing. There are many problems about and objections to situations such as the judges' transferring the cases to the higher courts because of inadequacy or their giving their judgements on their conscience only.

The aim of this study is to calculate the closeness of the judges' decisions to the ideal ones to find a similarity value and by using this value to make the judges to revise their decisions before any objections can be made. Initially, an algorithm is defined to find the similarity value. In the algorithm, first, the set of lawsuits is determined and the lawsuits are given weight values according to their importance. The set of defendants is formed. Then, an ideal decision set is determined which consists of the accurate decisions of each lawsuit. This set is written in terms of a generalized set valued neutrosophic quadruple set. Also, on a table, the set of decisions concerning each defendant's lawsuit is written as a generalized set valued neutrosophic quadruple set. This table enables us to see each defendant and each decision on lawsuits easier. Then, Hamming similarity measure on generalized set valued neutrosophic quadruple sets is used to calculate the closeness of the judges' decisions to the ideal decisions. The results are multiplied by the weight of each lawsuit. The similarity measures gathered from the lawsuits of each defendant is added. The closer this value to 1, the closer the decision is to the ideal one. In other words, the accuracy of the judges' decision is shown.

2. Preliminaries

Definition 1: [1] Let E be the universal set. A neutrosophic set A on E is denoted by

$$A = \{(x, T_A(x), I_A(x), F_A(x)) : x \in E\}$$

where $\forall x \in E, 0^- \leq T_A(x) + I_A(x) + F_A(x) \leq 3^+$ and the functions $T_A: E \rightarrow]^-0, 1^+[$, $I_A: E \rightarrow]^-0, 1^+[$ and $F_A: E \rightarrow]^-0, 1^+[$.

Here, $T_A(x)$, $I_A(x)$ and $F_A(x)$ are the degrees of trueness, indeterminacy and falsity respectively. Also, $^-0 = 0 + \varepsilon$ and $1^+ = 1 + \varepsilon$.

Definition 2: [4] Let E be the universal set. A single-valued neutrosophic set A on E is denoted by

$$A = \{(x, T_A(x), I_A(x), F_A(x)) : x \in E\}$$

where $\forall x \in E, 0^- \leq T_A(x) + I_A(x) + F_A(x) \leq 3$ and the functions $T_A: E \rightarrow [0, 1]$, $I_A: E \rightarrow [0, 1]$ and $F_A: E \rightarrow [0, 1]$.

Here, $T_A(x)$, $I_A(x)$ and $F_A(x)$ are the degrees of trueness, indeterminacy and falsity respectively.

Definition 3: [16] A neutrosophic quadruple number has the form (a, bT, cI, dF) . Here, a, b, c, d are real or complex numbers and T, I, F are the degrees of trueness, indeterminacy and falsity values in terms of neutrosophy. In this context, the neutrosophic quadruple numbers set NQ is defined as

$$NQ = \{(a, bT, cI, dF) : a, b, c, d \in \mathbb{R} \text{ or } \mathbb{C}\}$$

where the number (a, bT, cI, dF) represents any asset such as a number, an object, an idea, etc. The number a is defined as called the known part and (bT, cI, dF) is called the unknown part here.

Definition 4: [22] Let X be a set and let $P(X)$ be the power set of X . A generalized set valued neutrosophic quadruple set is of the form:

$$G_{S_i} = \{(A_{S_i}, B_{S_i}T_{S_i}, C_{S_i}I_{S_i}, D_{S_i}F_{S_i}) : A_{S_i}, B_{S_i}, C_{S_i}, D_{S_i} \in P(X); i = 1, 2, 3, \dots, n\}$$

where T_i , I_i and F_i are the usual neutrosophic logic tools and $G_{N_i} = (A_{S_i}, B_{S_i}T_{S_i}, C_{S_i}I_{S_i}, D_{S_i}F_{S_i})$ is generalized set valued neutrosophic quadruple number.

Also, $(A_{S_i}, B_{S_i}T_{S_i}, C_{S_i}I_{S_i}, D_{S_i}F_{S_i})$ represents any asset, A_{S_i} is called the known part and $(B_{S_i}T_{S_i}, C_{S_i}I_{S_i}, D_{S_i}F_{S_i})$ is called the unknown part.

Definition 5: [24] Let X be a non – empty set,

$G_{N_1} = (K_1, L_1T_1, M_1I_1, N_1F_1)$ and $G_{N_2} = (K_2, L_2T_2, M_2I_2, N_2F_2)$ be two generalized set valued neutrosophic quadruple numbers, $S_H : G_{N_1} \times G_{N_2} \rightarrow [0, 1]$ be a function. Then,

$$S_H(G_{N_1}, G_{N_2}) =$$

$$1 - \frac{1}{2} \left[\frac{|T_1 - T_2| + |I_1 - I_2| + |F_1 - F_2|}{3} + \frac{4 - \left[\frac{s(K_1 \cap K_2)}{\max\{s(K_1 \cup K_2), 1\}} + \frac{s(L_1 \cap L_2)}{\max\{s(L_1 \cup L_2), 1\}} + \frac{s(M_1 \cap M_2)}{\max\{s(M_1 \cup M_2), 1\}} + \frac{s(N_1 \cap N_2)}{\max\{s(N_1 \cup N_2), 1\}} \right]}{4} \right]$$

is called generalized Hamming similarity measure for generalized set valued neutrosophic quadruple numbers. Where, $s(A)$ is the number of element of $A \in X$.

3. The Algorithm That Eases The Judges' Decision Making Defined By Hamming Measures on Set Valued Neutrosophic Quadruple Sets

It is possible that the decisions made by the judges are not always in accordance with the law since the personal opinions of the judges, the conditions of the defendants and the subjects of the lawsuits are not always identical. In such cases, it is normal for the decisions to be changed. However, as there are so many uncertain situations today, the objections to the judges' decisions have increased, when the judges have difficulty in making decisions, they transfer cases to higher courts, and the judges have more instinctive tendencies while directing trials. From the point of view of law, there are certain decisions that must be made according to the cases. The judges are asked to make these decisions not only by their conscience but by taking into account the cases and the status of the defendants. In doing so, they should benefit from the law. Here, an algorithm is introduced that allows us to see how correct the decisions of judges in cases are with respect to the law. Using this algorithm, it is aimed to reduce objections to judges' decisions, to reduce the transfer of cases to higher courts, and to make ideal decisions closest to the law.

3.1 Algorithm

This is an algorithm that makes it easier for us to find out how accurate the decision was made according to the constitution.

1. Step:

Let the set of lawsuits be

$$H = \{h_1, h_2, \dots, h_m\}.$$

2. Step:

Let the set of the weight values of the lawsuits according to their importance be

$$G = \{g_1, g_2, \dots, g_m\}.$$

In other words;

weight value of the lawsuit h_1 is g_1 ,

weight value of the lawsuit h_2 is g_2 ,

.

.

.

weight value of the lawsuit h_m is g_m .

Also, $\sum_{j=1}^m g_j = 1$.

3. Step:

Let I be the ideal set. For the generalized set valued neutrosophic quadruple number

$$I = \{h_1: (P(N), P(N)T_{1i}, \emptyset I_{1i}, \emptyset F_{1i}), h_2: (P(Z), P(Z)T_{2i}, \emptyset I_{2i}, \emptyset F_{2i}), \dots, h_m: (P(W), P(W)T_{ni}, \emptyset I_{ni}, \emptyset F_{ni})\},$$

the set of decision that must be given for the condition $P(N)$ of the lawsuit d_1 , the set of decision that must be given for the situation $(P(N)T_{1j}, \emptyset I_{1j}, \emptyset F_{1j})$,

the set of decision that must be given for the condition $P(Z)$ of the lawsuit d_2 , the set of decision that must be given for the situation $(P(Z)T_{2j}, \emptyset I_{2j}, \emptyset F_{2j})$,

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the set of decision that must be given for the condition $P(W)$ of the lawsuit d_m , the set of decision that must be given for the situation $(P(W)T_{mj}, \emptyset I_{mj}, \emptyset F_{mj})$, and let $N = \{n_1, n_2, \dots, n_m\}$, $Z = \{z_1, z_2, \dots, z_m\}, \dots$, $W = \{w_1, w_2, \dots, w_m\}$ be the sets of the decided cases. Take

$$T_{1i} = T_{2i} = \dots = T_{ni} = 1$$

$$I_{1i} = I_{2i} = \dots = I_{ni} = 0$$

$$F_{1i} = F_{2i} = \dots = F_{ni} = 0.$$

4. Step:

Let the set of the defendants be $X = \{X_1, X_2, \dots, X_m\}$. Let us express the decision for the lawsuits of each defendant in this set by a set valued neutrosophic quadruple

$$X_1 = \{h_1: (N_{11}, N_{12}T_{11}, N_{13}I_{11}, N_{14}F_{11}), h_2: (Z_{11}, Z_{12}T_{12}, Z_{13}I_{12}, Z_{14}F_{12}), \dots, h_m: (W_{11}, W_{12}T_{1m}, W_{13}I_{1m}, W_{14}F_{1m})\}$$

$$X_2 = \{h_1: (N_{2_1}, N_{2_2}T_{2_1}, N_{2_3}I_{2_1}, N_{2_4}F_{2_1}), h_2: (Z_{2_1}, Z_{2_2}T_{2_2}, Z_{2_3}I_{2_2}, Z_{2_4}F_{2_2}), \dots, \\ h_m: (W_{2_1}, W_{2_2}T_{2_m}, W_{2_3}I_{2_m}, W_{2_4}F_{2_m})\}$$

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$$X_n = \{h_1: (N_{n_1}, N_{n_2}T_{n_1}, N_{n_3}I_{n_1}, N_{n_4}F_{n_1}), h_2: (Z_{n_1}, Z_{n_2}T_{n_2}, Z_{n_3}I_{n_2}, Z_{n_4}F_{n_2}), \dots, \\ h_m: (W_{n_1}, W_{n_2}T_{n_m}, W_{n_3}I_{n_m}, W_{n_4}F_{n_m})\}$$

where $K_{ij} \in P(N)$, $L_{ij} \in P(Z)$, $\dots$, $Z_{ij} \in P(W)$ ($i = 1, 2, 3, 4$) ($j = 1, 2, \dots, n$).

5. Step:

Denote the decisions given in the lawsuits of the generalized set valued neutrosophic quadruple defendants in a table.

Table 1. Matrix presentation of the decisions given per defendants

	h_1	h_2	$\dots$	h_m
X_1	$(N_{1_1}, N_{1_2}T_{1_1}, N_{1_3}I_{1_1}, N_{1_4}F_{1_1})$	$(Z_{1_1}, Z_{1_2}T_{1_2}, Z_{1_3}I_{1_2}, Z_{1_4}F_{1_2})$	$\dots$	$(W_{1_1}, W_{1_2}T_{1_m}, W_{1_3}I_{1_m}, W_{1_4}F_{1_m})$
X_2	$(N_{2_1}, N_{2_2}T_{2_1}, N_{2_3}I_{2_1}, N_{2_4}F_{2_1})$	$(Z_{2_1}, Z_{2_2}T_{2_2}, Z_{2_3}I_{2_2}, Z_{2_4}F_{2_2})$	$\dots$	$(W_{2_1}, W_{2_2}T_{2_m}, W_{2_3}I_{2_m}, W_{2_4}F_{2_m})$
.	.	.	$\dots$	.
.	.	.	.	.
.	.	.	.	.
X_n	$(N_{n_1}, N_{n_2}T_{n_1}, N_{n_3}I_{n_1}, N_{n_4}F_{n_1})$	$(Z_{n_1}, Z_{n_2}T_{n_2}, Z_{n_3}I_{n_2}, Z_{n_4}F_{n_2})$	$\dots$	$(W_{n_1}, W_{n_2}T_{n_m}, W_{n_3}I_{n_m}, W_{n_4}F_{n_m})$

6. Step:

Calculate the Hamming similarity measure of each lawsuit of the defendants in Table.1 with the ideal set.

Table 2. Table of the Hamming similarity measure between the defendants and the ideal set

	h_1	h_2	...	h_m
X_1	$V_H(I_{h_1}, X_{1h_1})$	$V_H(I_{h_2}, X_{1h_2})$	...	$V_H(I_{h_m}, X_{1h_m})$
X_2	$V_H(I_{h_1}, X_{2h_1})$	$V_H(I_{h_2}, X_{2h_2})$	...	$V_H(I_{h_m}, X_{2h_m})$
.	.	.	...	.
.	.	.	.	.
.	.	.	.	.
X_n	$V_H(I_{h_1}, X_{nh_1})$	$V_H(I_{h_2}, X_{nh_2})$	...	$V_H(I_{h_m}, X_{nh_m})$

7. Step:

Multiply the similarity measure in Table 2 with the weight value of each criterion ($h=1,2,\dots, n$). So, we get the ixn type weighted similarity matrice in Table 3.

Table 3. Table of weighted similarity of the given decisions and the ideal set

	$g_1 h_1$	$g_2 h_2$	...	$g_m h_m$
X_1	$g_1 \cdot V_H(I_{h_1}, X_{1h_1})$	$g_2 \cdot V_H(I_{h_2}, X_{1h_2})$	...	$g_m \cdot V_H(I_{h_m}, X_{1h_m})$
X_2	$g_1 \cdot V_H(I_{h_1}, X_{2h_1})$	$g_2 \cdot V_H(I_{h_2}, X_{2h_2})$	...	$g_m \cdot V_H(I_{h_m}, X_{2h_m})$
.	.	.	...	.
.	.	.	.	.
.	.	.	.	.
X_n	$g_1 \cdot V_H(I_{h_1}, X_{nh_1})$	$g_2 \cdot V_H(I_{h_2}, X_{nh_2})$	...	$g_m \cdot V_H(I_{h_m}, X_{nh_m})$

8. Step:

In this last step, we obtain the similarity rate of each decision to the ideal decision by adding up the weighted similarity values of each lawsuit in Table 7.

Table 4. Similarity value matrice of the lawsuits to the ideal lawsuits

	Similarity Value
X_1	$V_{H^1}(I, X_1)$
X_2	$V_{H^2}(I, X_2)$
.	.
.	.
.	.
X_n	$V_{H^n}(I, X_n)$

3.2 Application**1. Step:**

Let the set of lawsuits be

$$D = \{\text{bodily injury, sexual harassment, drug production and trafficking}\}.$$

2. Step:

Let the weight values of the lawsuits be

0.1 for bodily injury,

0.8 for sexual harassment and

0.1 for drug production and trafficking.

3. Step: Let I be the ideal set. For the generalized set valued neutrosophic quadruple number

$I = \text{bodily injury} : (\{\text{imprisonment, fine}\}, \{\text{imprisonment, suspension}\} 1, \emptyset 0, \emptyset 0),$

$\text{sexual harassment} : (\{\text{imprisonment}\}, \{\text{imprisonment, fine}\} 1, \emptyset 0, \emptyset 0),$

$\text{drug production and trafficking} : (\{\text{imprisonment, aggravated life sentence}\}, \{\text{imprisonment, fine}\} 1, \emptyset 0, \emptyset 0),$

decision for the bodily injury lawsuit according to the constitution $\{\text{imprisonment, fine}\}$, decision with respect to the conditions of the case and the defendant $(\{\text{imprisonment, suspension}\} 1, \emptyset 0, \emptyset 0),$

decision for the sexual harassment lawsuit according to the constitution $\{\text{imprisonment}\}$, decision with respect to the conditions of the case and the defendant $(\{\text{imprisonment, fine}\} 1, \emptyset 0, \emptyset 0),$

decision for the drug production and trafficking lawsuit according to the constitution $\{\text{imprisonment, aggravated life imprisonment}\}$, decision with respect to the conditions of the case and the defendant $(\{\text{imprisonment, fine}\} 1, \emptyset 0, \emptyset 0)$ and let

$K = \{\text{suspension, imprisonment, life sentence, aggravated life sentence}\},$

$L = \{\text{imprisonment, fine}\}$

$H = \{\text{imprisonment, fine, acquitment}\}.$

4. Step:

Let the set of the defendants be $X = \{X_1, X_2, X_3, X_4, X_5\}.$

$X_1 = \{\text{bodily injury} : (\{\text{imprisonment, suspension, acquitment}\}, \{\text{acquitment, suspension}\} (0.3), \{\text{suspension, imprisonment}\} (0.4), \{\text{aggravated life sentence}\} (0.2)),$

$\text{sexual harassment} : (\{\text{fine, imprisonment}\}, \{\text{fine}\} (0.6), \{\text{imprisonment}\} (0.1), \{\text{fine}\} (0.1)),$

$\text{drug production and trafficking} : (\{\text{fine, acquitment, imprisonment}\}, \{\text{imprisonment, acquitment}\} (0.1), \{\text{imprisonment, fine}\} (0.2), \emptyset (0.7))\}.$

$X_2 = \{\text{bodily injury} : (\{\text{suspension, acquitment, aggravated life sentence}\}, \{\text{suspension}\} (0.6), \{\text{suspension, imprisonment, acquitment}\} (0.9), \{\text{aggravated life sentence}\} (0)),$

$\text{sexual harassment} : (\{\text{fine, imprisonment}\}, \{\text{imprisonment}\} (0.6), \emptyset (0.1), \{\text{fine}\} (0.4)),$

$\text{drug production and trafficking} : (\{\text{fine, imprisonment, acquitment}\}, \{\text{imprisonment}\} (0.3), \{\text{imprisonment, fine, acquitment}\} (0.1), \emptyset (0.8))\}.$

$X_3 = \{\text{bodily injury} : (\{\text{suspension, acquitment, imprisonment, aggravated life sentence}\}, \{\text{suspension, acquitment}\} (0.8), \{\text{suspension, imprisonment, acquitment}\} (0.2), \emptyset (0)),$

$\text{sexual harassment} : (\{\text{fine, imprisonment}\}, \{\text{fine}\} (0), \{\text{imprisonment}\} (0.4), \{\text{fine}\} (0.3)),$

$\text{drug production and trafficking} : (\{\text{fine, imprisonment, acquitment}\}, \{\text{acquitment}\} (0.7), \{\text{imprisonment, fine, acquitment}\} (0.6), \{\text{fine}\} (0.5))\}.$

$X_4 = \{\text{bodily injury} : (\{\text{suspension, acquitment, imprisonment}\}, \{\text{suspension, acquitment}\}(0.7), \{\text{suspension, imprisonment, acquitment}\}(0), \{\text{imprisonment}\}(0.1)),$

$\text{sexual harassment} : (\{\text{fine, imprisonment}\}, \{\text{fine}\}(0.2), \{\text{fine, imprisonment}\}(0.6), \{\text{fine}\}(0.8)),$

$\text{drug production and trafficking} : (\{\text{fine, imprisonment}\}, \{\text{imprisonment}\}(0.4), \{\text{fine, imprisonment}\}(0.5), \emptyset(0.1))\}.$

$X_5 = \{\text{bodily injury} : (\{\text{suspension, acquitment, imprisonment, aggravated life sentence}\}, \{\text{suspension}\}(0.9), \{\text{suspension}\}(0), \{\text{imprisonment}\}(0.8)),$

$\text{sexual harassment} : (\{\text{fine, imprisonment}\}, \{\text{fine, imprisonment}\}(0.2), \{\text{imprisonment}\}(0.5), \{\text{fine, imprisonment}\}(0.3)),$

$\text{drug production and trafficking} : (\{\text{fine, imprisonment, acquitment}\}, \{\text{acquitment, fine}\}(0.6), \{\text{imprisonment, fine, acquitment}\}(0.2), \{\text{fine, acquitment}\}(0))\}.$

5. Step:

Denote the decisions given in the lawsuits of the generalized set valued neutrosophic quadruple defendants in a table.

Table 1. Presentation of the decisions given per defendant

	Bodily Injury	Sexual Harassment	Drug Production and Trafficking
X_1	$(\{\text{imprisonment, suspension, acquitment}\}, \{\text{acquitment, suspension}\}(0.3), \{\text{suspension, imprisonment}\}(0.4), \{\text{aggravated life sentence}\}(0.2)).$	$(\{\text{fine, imprisonment}\}, \{\text{fine}\}(0.6), \{\text{imprisonment}\}(0.1), \{\text{fine}\}(0.1)).$	$(\{\text{fine, acquitment, imprisonment}\}, \{\text{imprisonment, acquitment}\}(0.1), \{\text{imprisonment, fine}\}(0.2), \emptyset(0.7)),$
X_2	$(\{\text{suspension, acquitment, imprisonment, aggravated life sentence}\}, \{\text{suspension}\}(0.6), \{\text{suspension, imprisonment, acquitment}\}(0.9), \{\text{aggravated life sentence}\}(0)).$	$(\{\text{fine, imprisonment}\}, \{\text{imprisonment}\}(0.6), \emptyset(0.1), \{\text{fine}\}(0.4)).$	$(\{\text{fine, imprisonment, acquitment}\}, \{\text{imprisonment}\}(0.3), \{\text{imprisonment, fine, acquitment}\}(0.1), \emptyset(0.8)),$
X_3	$(\{\text{suspension, acquitment, imprisonment, aggravated life sentence}\}, \{\text{suspension, acquitment}\}(0.8), \{\text{suspension, imprisonment, acquitment}\}(0.2), \emptyset(0)).$	$(\{\text{fine, imprisonment}\}, \{\text{fine}\}(0), \{\text{imprisonment}\}(0.4), \{\text{fine}\}(0.3)).$	$(\{\text{fine, imprisonment, acquitment}\}, \{\text{acquitment}\}(0.7), \{\text{imprisonment, fine, acquitment}\}(0.6), \{\text{fine}\}(0.5)),$
X_4	$(\{\text{suspension, acquitment, imprisonment}\}, \{\text{suspension, acquitment}\}(0.7), \{\text{suspension, imprisonment, acquitment}\}(0),$	$(\{\text{fine, imprisonment}\}, \{\text{fine}\}(0.2), \{\text{fine, imprisonment}\}(0.6), \{\text{fine}\}(0.8)).$	$(\{\text{fine, imprisonment}\}, \{\text{imprisonment}\}(0.4), \{\text{fine, imprisonment}\}(0.5), \emptyset(0.1)),$

	{imprisonment} (0.1)),		
X_5	{suspension, acquitment, imprisonment, aggravated life sentence}, {suspension}(0.9), {suspension}(0), {imprisonment}(0.8)),	{fine, imprisonment}, {fine, imprisonment}(0.2), {imprisonment}(0.5), {fine, imprisonment}(0.3)).	{fine, imprisonment, acquitment}, {acquitment, fine}(0.6), {imprisonment, fine, acquitment}(0.2), {fine, acquitment} (0))},

6. Step:

Calculate the similarity value of the given decisions to the ideal decisions.

Table 2. Table of the similarity between the given and ideal decisions

	Bodily Injury	Sexual Harassment	Drug Production and Trafficking
X_1	0.3667	0.4625	0.2937
X_2	0.3772	0.4750	0.2750
X_3	0.7083	0.3417	0.3500
X_4	0.5079	0.2600	0.4041
X_5	0.4437	0.3583	0.5250

7. Step:

Multiply the h-th similarity measure in Table 2 with the weight value of each criterion ($h=1,2,\dots, n$). So, we get the ixn type weighted similarity matrix in Table 3.

Table 3. Table of weighted similarity of the given decisions and the ideal set

	(0,1).Bodily injury	(0,8).Sexual Harassment	(0,1).Drug Production and Trafficking
X_1	0.0366	0,3700	0,0293
X_2	0,0377	0,3800	0,0275
X_3	0,0708	0,2732	0,0350
X_4	0,0507	0.2080	0,0404
X_5	0,0443	0,3549	0,0525

8. Step:

In this last step, the results of the similarity value matrice in Table 3 are acquired.

Table 4. Table of Similarity Values

	Similarity Value
X_1	$V_{H^1}(I, X_1) = 0,4359$
X_2	$V_{H^2}(I, X_2) = 0,4452$
X_3	$V_{H^3}(I, X_3) = 0,3790$
X_4	$V_{H^4}(I, X_4) = 0,2991$
X_5	$V_{H^5}(I, X_5) = 0,4517$

$$X_5 > X_2 > X_1 > X_3 > X_4$$

After the calculations, we see that the most accurate decision is given to X_5 and has a similarity value of 0,4517.

3.3 Application

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1. Step:

Let the set of the lawsuits be

$$D = \{\text{willful murder, burglary, child sexual abuse, fraud}\}.$$

2. Step:

The weights of the lawsuits were determined to be,

0.5 for wishfull murder,

0.1 for burglary,

0.3 for child sexual abuse and

0.1 for fraud.

3. Step: Let I be the ideal set. For the generalized set valued neutrosophic quadruple number

$I =$ wishfull murder:({imprisonment, fine, life sentence},{imprisonment, fine} 1, $\emptyset$, $\emptyset$),
 burglary:({imprisonment, fine},{imprisonment, fine} 1, $\emptyset$, $\emptyset$), child sexual
 abuse:({imprisonment, aggravated life sentence},{imprisonment, acquitment, fine} 1, $\emptyset$, $\emptyset$),
 fraud:({imprisonment, aggravated life sentence, fine, acquitment},{imprisonment, fine} 1, $\emptyset$, $\emptyset$),

decision for the wishfull murder lawsuit according to the constitution {imprisonment, fine, life sentence}, decision with respect to the conditions of the case and the defendant ({imprisonment, fine} 1, $\emptyset$, $\emptyset$),

decision for the burglary lawsuit according to the constitution {imprisonment, fine}, decision with respect to the conditions of the case and the defendant ({imprisonment, fine} 1, $\emptyset$, $\emptyset$),

decision for the child sexual abuse lawsuit according to the constitution {imprisonment, aggravated life imprisonment}, decision with respect to the conditions of the case and the defendant ({imprisonment, acquitment, fine} 1, $\emptyset$, $\emptyset$),

decision for the fraud lawsuit according to the constitution {imprisonment, aggravated life sentence, fine, acquitment}, decision with respect to the conditions of the case and the defendant ({imprisonment, fine} 1, $\emptyset$, $\emptyset$) and let

$A = \{\text{suspension, imprisonment, acquitment, aggravated life sentence, life sentence}\}$,

$B = \{\text{imprisonment, fine, acquitment}\}$,

$C = \{\text{imprisonment, fine, acquitment, life sentence}\}$

$D = \{\text{imprisonment, fine, life sentence}\}.$

4. Step:

Let the set of the defendants be $X = \{X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}\}$.

$X_1 = \{\text{wishfull murder}:(\{\text{imprisonment, suspension, acquitment, life sentence, aggravated life sentence}\}, \{\text{acquitment, imprisonment}\}(0.3), \{\text{suspension, acquitment, imprisonment}\}(0.8), \{\text{aggravated life sentence, imprisonment}\}(0)),$

$\text{burglary}:(\{\text{fine, acquitment, imprisonment}\}, \{\text{fine}\}(0.2), \{\text{imprisonment}\}(0.1), \{\text{fine}\}(0.6)),$

$\text{child sexual abuse}:(\{\text{fine, acquitment, imprisonment, life sentence}\}, \{\text{imprisonment, acquitment, life sentence}\}(0.7), \{\text{imprisonment, acquitment, fine}\}(0.3), \{\text{acquitment, fine}\}(0.4)),$

$\text{fraud}:(\{\text{fine, imprisonment}\}, \emptyset(0.1), \{\text{imprisonment, fine}\}(0.2), \emptyset(0.7)),$

$X_2 = \{\text{wishfull murder}:(\{\text{suspension, acquitment, imprisonment, aggravated life sentence}\}, \{\text{suspension}\}(0.2), \{\text{suspension, imprisonment, acquitment}\}(0), \{\text{aggravated life sentence}\}(0.4)),$

$\text{burglary}:(\{\text{fine, imprisonment, acquitment}\}, \{\text{imprisonment}\}(0.6), \{\text{fine, acquitment}\}(0.1), \{\text{fine}\}(0.4)),$

$\text{child sexual abuse}:(\{\text{fine, imprisonment, acquitment}\}, \emptyset(0.3), \{\text{imprisonment, fine, acquitment}\}(0), \{\text{acquitment}\}(0.6)),$

$\text{fraud}:(\{\text{fine, life sentence, imprisonment}\}, \{\text{imprisonment}\}(0.2), \{\text{imprisonment, fine}\}(0.2), \{\text{fine, life sentence, imprisonment}\}(0.8)).$

$X_3 = \{\text{wishfull murder}:(\{\text{suspension, acquitment, imprisonment, aggravated life sentence}\}, \{\text{suspension, acquitment}\}(0.8), \{\text{suspension, imprisonment, acquitment}\}(0.2), \emptyset(0)),$

$\text{burglary}:(\{\text{fine, imprisonment}\}, \{\text{fine}\}(0), \{\text{imprisonment}\}(0.4), \{\text{fine}\}(0.3)),$

$\text{child sexual abuse}:(\{\text{fine, imprisonment, acquitment}\}, \{\text{acquitment}\}(0.2), \{\text{imprisonment, fine, acquitment}\}(0.9), \{\text{fine}\}(0.8)),$

$\text{fraud}:(\{\text{fine, imprisonment, life sentence}\}, \{\text{imprisonment}\}(0.2), \{\text{imprisonment, fine}\}(0.1), \{\text{fine, imprisonment, life sentence}\}(0.6)).$

$X_4 = \{\text{wishfull murder}:(\{\text{suspension, acquitment, imprisonment}\}, \{\text{suspension, acquitment}\}(0.6), \emptyset(0), \{\text{imprisonment}\}(0.1)),$

$\text{burglary}:(\{\text{fine, imprisonment}\}, \emptyset(0.2), \{\text{fine, imprisonment}\}(0.6), \{\text{fine}\}(0.8)),$

$\text{child sexual abuse}:(\{\text{fine, imprisonment}\}, \{\text{imprisonment}\}(0.3), \{\text{fine, imprisonment}\}(0.9), \emptyset(0.1)),$

$\text{fraud}:(\{\text{fine, life sentence, imprisonment}\}, \{\text{imprisonment, life sentence}\}(0.1), \{\text{imprisonment, fine}\}(0.2), \{\text{life sentence}\}(0.3)).$

$X_5 = \{\text{wishfull murder}:(\{\text{suspension, acquitment, imprisonment, aggravated life sentence}\}, \{\text{suspension}\}(0.9), \{\text{suspension}\}(0.4), \{\text{imprisonment}\}(0.8)),$

burglary:({fine, imprisonment},{fine, imprisonment}(0),{imprisonment}(0.5),{acquittment, imprisonment}(0.3)),
 child sexual abuse:({fine, imprisonment, acquittment},{acquittment, fine}(0.6){imprisonment, fine,
 acquittment}(0.6),{fine, acquittment} (0.5)),
 fraud:({fine, life sentence, imprisonment},{imprisonment}(0.3),{imprisonment, fine}(0.9), {life sentence} (0.2))).

$X_6 = \{ \text{wishfull murder:}(\{ \text{suspension, acquittment, imprisonment, aggravated life sentence} \},$
 $\{ \text{suspension} \}(0.7), \{ \text{suspension} \}(0.8), \{ \text{imprisonment} \}(0.3)),$

burglary:({fine, imprisonment},{fine, imprisonment}(0.6), {imprisonment}(0.4),{fine, imprisonment}(0.4)),
 child sexual abuse:({fine, imprisonment, acquittment, life sentence},{acquittment, fine}(0.6) {imprisonment, fine,
 acquittment}(0.7),{fine, acquittment, life sentence} (0))),
 fraud:({fine, imprisonment},{imprisonment}(0.8),{imprisonment, fine}(0.4), (0))).

$X_7 = \{ \text{wishfull murder:}(\{ \text{suspension, acquittment, imprisonment, aggravated life sentence} \},$
 $\{ \text{suspension} \}(0.2), \{ \text{suspension} \}(0.7), \{ \text{imprisonment, aggravated life sentence} \}(0.6)),$

burglary:({fine, acquittment, imprisonment},{fine, imprisonment}(0.5), {imprisonment, acquittment}(0.5),{fine,
 imprisonment}(0.9)),
 child sexual abuse:({fine, imprisonment, acquittment},{acquittment, fine}(0.2){imprisonment, fine,
 acquittment}(0.2),{fine, acquittment} (0.8))),
 fraud:({fine, imprisonment},{imprisonment}(0.1),{imprisonment, fine}(0.2), $\emptyset$ (0))).

$X_8 = \{ \text{wishfull murder:}(\{ \text{suspension, acquittment, imprisonment, aggravated life sentence} \},$
 $\{ \text{suspension} \}(0.1), \{ \text{suspension} \}(0.4), \{ \text{imprisonment} \}(0.8)),$

burglary:({fine, imprisonment},{fine, imprisonment}(0.2), {imprisonment}(0.5),{fine, imprisonment}(0.2)),
 child sexual abuse:({fine, imprisonment, acquittment},{acquittment, fine}(0.6){imprisonment, fine,
 acquittment}(0.6),{fine, acquittment} (0.3))),
 fraud:({fine, life sentence, imprisonment},{imprisonment, life sentence}(0.6),{imprisonment,
 fine}(0.7),{imprisonment} (0.8))).

$X_9 = \{ \text{wishfull murder:}(\{ \text{suspension, acquittment, imprisonment, aggravated life sentence} \},$
 $\{ \text{suspension} \}(0), \{ \text{imprisonment} \}(0.7), \{ \text{imprisonment, acquittment} \}(0.2)),$

burglary:({fine, imprisonment},{fine, imprisonment}(0.7), {imprisonment}(0.2),{fine, imprisonment}(0.9)),
 child sexual abuse:({fine, imprisonment, acquittment},{acquittment, fine}(0.6), $\emptyset$ (0.2),{fine, acquittment} (0))),

fraud:({fine, life sentence, imprisonment},{imprisonment, acquitment}(0.1),{imprisonment, fine}(0.2), {life sentence, fine}(0.8)).

$X_{10} = \{\text{wishfull murder:}(\{\text{suspension, acquitment, imprisonment, aggravated life sentence, life sentence}\}, \{\text{life sentence, imprisonment, suspension}\}(0.2), \{\text{suspension}\}(0.1), \{\text{imprisonment, aggravated life sentence}\}(0.4)),$

burglary:({fine, imprisonment},{fine, imprisonment}(0.4), {imprisonment}(0.5),{fine, imprisonment}(0.2)),

child sexual abuse:({fine, imprisonment, acquitment},{acquitment, fine}(0.2){imprisonment, fine, acquitment}(0.6), $\emptyset$ (0))),

fraud:({fine, imprisonment},{imprisonment}(0.1),{imprisonment, fine}(0.8), {fine}(0.1))).

5. Step:

Now, we denote the decisions given in a table.

Table 1. Presentation of the decisions given per defendant

	Wishfull Murder	Burglary	Child Sexual Abuse	Fraud
X_1	({imprisonment, suspension, acquitment, life sentence, aggravated life sentence}, {acquitment, imprisonment}(0.3), {suspension, acquitment, imprisonment}(0.8), {aggravated life sentence, imprisonment}(0)),	({fine, acquitment, imprisonment}, {fine}(0.2), {imprisonment}(0.1), {fine}(0.6)),	({fine, acquitment, imprisonment, life sentence}, {imprisonment, acquitment, life sentence}(0.7), {imprisonment, acquitment, fine}(0.3), {acquitment, fine}((0.4))),	({fine, imprisonment}, $\emptyset$ (0.1), {imprisonment, fine}(0.2), $\emptyset$ (0.7))).
X_2	({suspension, acquitment, imprisonment, aggravated life sentence}, {suspension}(0.2), {suspension, imprisonment, acquitment}(0), {aggravated life sentence}(0.4)),	({fine, imprisonment, acquitment}, {imprisonment}(0.6), {fine, acquitment}(0.1), {fine}(0.4)),	({fine, imprisonment, acquitment}, $\emptyset$ (0.3), {imprisonment, fine, acquitment}(0), {acquitment}(0.6))),	({fine, life sentence, imprisonment}, {imprisonment}(0.2), {imprisonment, fine}(0.2), ({fine, life sentence, imprisonment}, {(0.8)}))
X_3	({suspension, acquitment, imprisonment, aggravated life sentence}, {suspension, acquitment}(0.8), {suspension, imprisonment, acquitment}(0.2), $\emptyset$ (0)),	({fine, imprisonment}, {fine}(0), {imprisonment}(0.4), {fine}(0.3)),	({fine, imprisonment, acquitment}, {acquitment}(0.2) {imprisonment, fine, acquitment}(0.9), {fine}(0.8))),	({fine, imprisonment, life sentence}, {imprisonment}(0.2), {imprisonment, fine}(0.1), {fine, imprisonment, life sentence}(0.6))).

X_4	({suspension, acquitment, imprisonment}, {suspension, acquitment}(0.6), $\emptyset$ (0), {imprisonment} (0.1)),	({fine, imprisonment}, $\emptyset$ (0.2), {fine, imprisonment}(0.6), {fine}(0.8)),	({fine, imprisonment}, {imprisonment}(0.3) {fine, imprisonment}(0.9), $\emptyset$ (0.1))),	({fine, life sentence, imprisonment}, {imprisonment, life sentence}(0.1), {imprisonment, fine}(0.2), {life sentence}(0.3))).
X_5	({suspension, acquitment, imprisonment, aggravated life sentence}, {suspension}(0.9), {suspension}(0.4), {imprisonment}(0.8)),	({fine, imprisonment}, {fine, imprisonment}(0), {imprisonment}(0.5), {acquitment, imprisonment}(0.3)),	({fine, imprisonment, acquitment}, {acquitment, fine}(0.6) {imprisonment, fine, acquitment}(0.6), {fine, acquitment} (0.5))),	({fine, life sentence, imprisonment}, {imprisonment}(0.3), {imprisonment, fine}(0.9), {life sentence}(0.2))).
X_6	({suspension, acquitment, imprisonment, aggravated life sentence}, {suspension}(0.7), {suspension}(0.8), {imprisonment}(0.3)),	({fine, imprisonment}, {fine, imprisonment}(0.6), {imprisonment}(0.4), {fine, imprisonment}(0.4)),	({fine, imprisonment, acquitment, life sentence}, {acquitment, fine}(0.6) {imprisonment, fine, acquitment}(0.7), {fine, acquitment, life sentence} (0))),	({fine, imprisonment}, {imprisonment}(0.8), {imprisonment, fine}(0.4), (0))).
X_7	({suspension, acquitment, imprisonment, aggravated life sentence}, {suspension}(0.2), {suspension}(0.7), {imprisonment, aggravated life sentence}(0.6)),	({fine, acquitment, imprisonment}, {fine, imprisonment}(0.5), {imprisonment, acquitment}(0.5), {fine, imprisonment}(0.9)),	({fine, imprisonment, acquitment}, {acquitment, fine}(0.2) {imprisonment, fine, acquitment}(0.2), {fine, acquitment} (0.8))),	({fine, imprisonment}, {imprisonment}(0.1), {imprisonment, fine}(0.2), $\emptyset$ (0))).
X_8	({suspension, acquitment, imprisonment, aggravated life sentence}, {suspension}(0.1), {suspension}(0.4), {imprisonment}(0.8)),	({fine, imprisonment}, {fine, imprisonment}(0.2), {imprisonment}(0.5), {fine, imprisonment}(0.2)),	({fine, imprisonment, acquitment}, {acquitment, fine}(0.6) {imprisonment, fine, acquitment}(0.6), {fine, acquitment} (0.3))),	({fine, life sentence, imprisonment}, {imprisonment, life sentence}(0.6), {imprisonment, fine}(0.7), {imprisonment} (0.8))).
X_9	({suspension, acquitment, imprisonment, aggravated life sentence}, {suspension}(0), {imprisonment}(0.7), {imprisonment, acquitment}(0.2)),	({fine, imprisonment}, {fine, imprisonment}(0.7), {imprisonment}(0.2), {fine, imprisonment}(0.9)),	({fine, imprisonment, acquitment}, {acquitment, fine}(0.6), $\emptyset$ (0.2), {fine, acquitment} (0))),	({fine, life sentence, imprisonment}, {imprisonment, acquitment}(0.1), {imprisonment, fine}(0.2), {life sentence, fine}(0.8))).
X_{10}	({suspension, acquitment, imprisonment, aggravated life sentence, life sentence}, {life sentence, imprisonment, suspension}(0.2), {suspension}(0.1), {imprisonment, aggravated life sentence}(0.4)),	({fine, imprisonment}, {fine, imprisonment}(0.4), {imprisonment}(0.5), {fine, imprisonment}(0.2)),	({fine, imprisonment, acquitment}, {acquitment, fine}(0.2) {imprisonment, fine, acquitment}(0.6), $\emptyset$ (0))),	({fine, imprisonment}, {imprisonment}(0.1), {imprisonment, fine}(0.8), {fine}(0.1))).

6. Step:

Calculate the similarity value of the given decisions to the ideal decisions.

Table 2. Table of the similarity between the given and ideal decisions

	Wishfull Murder	Burglary	Child Sexual Abuse	Fraud
X_1	0,3710	0,3750	0,4750	0,3875
X_2	0,3145	0,4958	0,5020	0,4187
X_3	0,3979	0,4041	0,3020	0,4062
X_4	0,4416	0,3833	0,3187	0,4020
X_5	0,3041	0,4500	0,4687	0,3562
X_6	0,2916	0,5166	0,4937	0,5250
X_7	0,1583	0,4333	0,3833	0,4416
X_8	0,1750	0,5000	0,4604	0,3604
X_9	0,2083	0,4333	0,5437	0,3187
X_{10}	0,3395	0,5333	0,4437	0,3250

7. Step:

Multiply the similarity measure in Table 2 with the weight value of each criterion ($h=1,2,\dots, n$). So, we get the ixn type weighted similarity matrice in Table 3.

Table 3. Table of weighted similarity of the given decisions and the ideal set

	(0,5).Wishfull Murder	(0,1).Burglary	(0,3).Child Sexual Abuse	(0,1).Fraud
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X_1	0,1855	0,0375	0,1425	0,0387
X_2	0,1572	0,0495	0,1506	0,0418
X_3	0,1989	0,0404	0,0906	0,0406
X_4	0,2208	0,0383	0,0956	0,0402
X_5	0,1520	0,0450	0,1406	0,0356
X_6	0,1458	0,0516	0,1481	0,0525
X_7	0,0791	0,0433	0,1149	0,0441
X_8	0,0875	0,0500	0,1381	0,0360
X_9	0,1041	0,0433	0,1631	0,0318
X_{10}	0,1697	0,0533	0,1331	0,0325

8. Step:

In this last step, the results of the similarity value matrice in Table 3 are acquired.

Table 4. Table of Similarity Values

	Similarity Value
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X_1	$V_{H^1}(I, X_1) = 0,4042$
X_2	$V_{H^2}(I, X_2) = 0,3991$
X_3	$V_{H^3}(I, X_3) = 0,3706$
X_4	$V_{H^4}(I, X_4) = 0,3949$
X_5	$V_{H^5}(I, X_5) = 0,3732$
X_6	$V_{H^6}(I, X_6) = 0,3980$
X_7	$V_{H^7}(I, X_7) = 0,2814$
X_8	$V_{H^8}(I, X_8) = 0,3116$
X_9	$V_{H^9}(I, X_9) = 0,3423$
X_{10}	$V_{H^{10}}(I, X_{10}) = 0,3886$

$$X_1 > X_2 > X_6 > X_4 > X_{10} > X_5 > X_3 > X_9 > X_8 > X_7$$

After the calculations, we see that the most accurate decision is given to defendant X_1 and has a similarity value of 0,4042.

4. Conclusion

In this study, an algorithm that aims to eliminate the problems in judges' decision-making is introduced. With this algorithm, it is aimed to see how close the judges' decisions are to the actual decisions, using the result obtained by calculating the similarity of the decisions of each case with respect to the ideal decision set. Here, the verdicts of each defendant in each case were written as generalized set valued neutrophic quadruples, and the similarity between the ideal decision set and the generalized set valued neutrophic quadruples was obtained by the Hamming similarity measure defined on the generalized set valued neutrophic quadruple sets and numbers. The closer this value to 1, the more accurate the decision will be. So, positive results are expected such as the judges' reviewing and correcting their decisions and hence decrease the number of objections against their decisions, and reducing the number of cases transferred to higher courts.. This introduced algorithm can be used for any type of lawsuit, any type of defendant in

any situation. In addition, it is possible to expand this algorithm as much as desired by increasing the number of defendants, lawsuits and decisions.

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