# Decision Making Applications for Business Based on Generalized Set-Valued Neutrosophic Quadruple Sets

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**Abstract**

In this article, an algorithm is introduced that makes it easier for us to choose the right operator in order to overcome the possible problems faced by a business, small or huge. This algorithm is based on the Euclidean similarity measure on generalized set-valued neutrosophic quadruple numbers and sets. By using this algorithm, one can calculate the similarity of the criteria between the requested and already owned skills of the operators in general. By this means, one can make the right choice to hire the right operator without giving preferential treatment or personal favors. The closer the similarity value is to 1, the more accurate our selection will be.

**Keywords:** neutrosophic set; generalized set valued neutrosophic quadruple numbers; generalized Euclid similarity measure; decision making, business

## 1. Introduction

In our daily life, we often make choices and we would like to minimize the number of options for a better choice. This also holds for all institutions everywhere. Sometimes we need to prefer a doctor, a teacher, an engineer, or a manager among a variety of options. But, can we be sure that our choices are easy or fair? Of course, we cannot. For example, do we know that a person got a job because he or she satisfied some conditions, or had he or she been personally favored? On the other hand, consider an honest business owner man; is it simple for him to find the right manager to entrust his business? How can he be sure about his selection method? We try to answer this and similar questions in this article.

The word "business" means to operate, and also a workplace. To serve in the business world, institutions or organizations, one should be competent in the areas such as finance, accounting, management, marketing, production, and human resources. A healthy business is easy to manage and generates good profits. However, a healthy business is generally dependent on the entrepreneur, that is, the operator. Whether the business is small or large, the problems are generally similar. Some of these problems are lack of planning, not giving sufficient importance to human resources, not being professional, communication problems, not having a corporate identity in relations, lack of organizational chart, structural problems, the inadequacy of accounting information flow system, company owner's/founder's making decisions alone, failure to establish a cost accounting system, not being able to base decisions on reports containing accurate information, making controls individually rather than systematically, lack of documented job descriptions, conflicts of interest and responsibilities, lack of healthy hierarchy, lack of documentation regulating the workflow, and not



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making a scientific-based assignment according to expertise and experience. The root cause of all these problems is the operator. If you have a skilled operator, the business will be healthy. So, the first thing we need to do is to find the right operator. In order to find the right operator, we need to make a decision. When choosing an operator, we should choose people who meet certain criteria.

In this article, an algorithm that is designed to help us, without making personal favors, to choose the right people to manage a business and to make the right decision is introduced. This algorithm is defined by Euclidean measures on generalized set-valued neutrosophic quadruple numbers and sets, and is used to calculate the similarity of the criteria between the requested and already owned skills of a business operator. By using this algorithm, the criteria for each skill owned by an operator can easily be observed. The closer the similarity value is to 1, the more accurate our selection will be.

In daily life, there are always instances of vagueness and uncertainty. Zadeh [1] introduced fuzzy logic and fuzzy sets to overcome vagueness for the first time in 1965 by using a new membership function. This membership value is defined to indicate the degree of membership of an object into the corresponding set and has a value between 0 and 1. Atanassov [2], in 1986, added a non-membership function to this membership function and defined the concepts of intuitionistic fuzzy logic and intuitionistic fuzzy sets and similarly defined the non-membership function to have values between 0 and 1. Neutrosophic logic and neutrosophic sets are more general concepts than fuzzy logic and intuitionistic logic, and is introduced by Smarandache [3] in 1998. In a neutrosophic set, there exists a value of membership $T$, a value of indeterminacy $I$, and a value of non-membership $F$ which are defined independently of each other. Thus, a lot of researchers studied based on neutrosophic theory [4-9]. Recently, Kargın et al. [10] introduced the generalized Hamming similarity measure based on neutrosophic quadruple numbers and their applications to the legal sciences; Şahin et al. [11] introduced Hausdorff measures of decision-making on the adequacy of online education based on generalized set-valued neutrosophic quadruple numbers; Aslan et al. [12] presented a decision-making application and neutrosophic modeling of Talcott Parsons's action; Smarandache and Ali [13] obtained neutrosophic triplet set and group; Kargın et al. [14] introduced neutrosophic triplet m-Banach space. Şahin et al. [15] obtained neutrosophic triplet bipolar metric space.

Smarandache [16] defined neutrosophic quadruple sets and neutrosophic quadruple numbers. A neutrosophic quadruple set is a more general structure than the neutrosophic set and is denoted as NQS= $\{(a, bT, cI, dF)$: $a, b, c, d \in \mathbb{R}$ or $\mathbb{C}\}$. Here, $a$ is called the known part, $(bT, cI, dF)$ is called the unknown part, and $T, I, F$ are the known neutrosophic logical tools. Thus, a lot of researchers studied neutrosophic quadruple structures [17-20]. Recently, Şahin and Kargın [21] introduced neutrosophic set valued quadruple set and set-valued neutrosophic quadruple number; Şahin et al. [22] introduced generalized neutrosophic set valued quadruple sets and numbers. In addition, numerous researchers studied neutrosophic quadruple structures. Kandasamy et al. [23] introduced neutrosophic quadruple vector spaces and their properties. Ma et al. [24] studied the structure of idempotents in neutrosophic rings and neutrosophic quadruple rings. Rezaei et al. defined neutrosophic a-ideals in [25].

In this paper, some basic definitions and properties are given in Section 2. In Section 3, an algorithm that eases the right decision-making to employ the right operator for a business is introduced. The aim of this algorithm is to calculate the similarity of the criteria between the requested and already owned skills of the operators. The value closest to 1 is preferred from similarity values and thus, one can make the best possible decision. Then, an example to illustrate the applicability of our algorithm is given. Section 4 consists of the results and proposals.

## 2. Preliminaries

**Definition 2.1: [3]** Let $E$ be the universal set. A neutrosophic set $A$ on $E$ is denoted by

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

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



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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 2.2: [26]** Let $E$ be the universal set. A single-valued neutrosophic set $A$ on $E$ is denoted by

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

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

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

**Theorem 2.3: [27]** Let $S: E \times E \to [0,1]$. The similarity measure between $A_1$ and $A_2$ is denoted by $S(A_1, A_2)$ and for the neutrosophic sets $A_1, A_2, A_3 \in E$, $S(A_1, A_2)$ satisfies the below conditions:

i. $0 \leq S(A_1, A_2) \leq 1$
ii. $S(A_1, A_2) = 1 \Leftrightarrow A_1 = A_2$
iii. $S(A_1, A_2) = S(A_2, A_1)$
iv. If $A_1 \subseteq A_2 \subseteq A_3 \in E$, then $S(A_1, A_3) \leq S(A_1, A_2)$ and $S(A_1, A_3) \leq S(A_2, A_3)$.

**Definition 2.4: [16]** NQN is a number of the form $(x, yT, zI, tF)$, where T, I, F are used as the usual neutrosophic logic tools and $x, y, z, t \in \mathbb{R}$ or $\mathbb{C}$. The NQS defined by NQS = $\{(x, yT, zI, tF)$: x, $y$, $z$, $t \in \mathbb{R}$ or $\mathbb{C}\}$.

For an NQN, In $(x, yT, zI, tF)$, $x$ is named as the known part and it represents any number, idea, object, etc. and $(yT, zI, tF)$) is named as the unknown part.

**Definition 2.5: [21]** Let $N$ be a set and let $P(N)$ be the power set of $N$. An SVNQN is of the form $(A_1, A_2 T, A_3 I, A_4 F)$. Here, T, I, F are the degrees of trueness, indeterminacy and falsity respectively. Also, $A_1, A_2, A_3, A_4 \in P(N)$. Here,

$$N_q = \{(A_1, A_2T, A_3I, A_4F): A_1, A_2, A_3, A_4 \in P(N)\}.$$

Similar to NQS, $A_1$ is called the known part and $(A_2T, A_3I, A_4F)$ is called the unknown part.

**Definition 2.8: [22]** Let $X$ be a set and let $P(X)$ be the power set of $X$. A Generalized element of the set SVNQS (GSVNQS) 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 by SVNQN (GSVNQN).

Similar to NQN, a GNQN $(A_{s_i}, B_{s_i}T_{s_i}, C_{s_i}I_{s_i}, D_{s_i}F_{s_i})$ 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.



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Also, $G_{s_i} = \{G_{N_i} : i = 1, 2, 3, \dots, n\}$ can be used as another representation.

**Definition 2.9: [27]** Let **:** $X \neq \emptyset$ be a non-empty set and $P(X)$ be the power set of $X$.

Let $G_{N_i^1} = (A_{S_i^1}, B_{S_i^1}T_{S_i^1}, C_{S_i^1}I_{S_i^1}, D_{S_i^1}F_{S_i^1})$ and $G_{N_i^2} = (A_{S_i^2}, B_{S_i^2}T_{S_i^2}, C_{S_i^2}I_{S_i^2}, D_{S_i^2}F_{S_i^2})$ be two generalized set-valued neutrosophic quadruple numbers.

Define a function $d_E: G_{N_i^1} \times G_{N_i^2} \to [0,1]$ such that

$$d_G\left(G_{N_i^1}, G_{N_i^2}\right) = \frac{1}{2}\left[\frac{\sqrt{\left(T_{S_i^1}-T_{S_i^2}\right)^2}+\sqrt{\left(I_{S_i^1}-I_{S_i^2}\right)^2}+\sqrt{\left(F_{S_i^1}-F_{S_i^2}\right)^2}}{3}\right.$$

$$\left.+\frac{\sqrt{\frac{s\left(A_{S_i^1}\backslash A_{S_i^2}\right)+s\left(A_{S_i^2}\backslash A_{S_i^1}\right)}{\max\{s\left(A_{S_i^1}\cup A_{S_i^2}\right),1\}}+\frac{s\left(B_{S_i^1}\backslash B_{S_i^2}\right)+s\left(B_{S_i^2}\backslash B_{S_i^1}\right)}{\max\{s\left(B_{S_i^1}\cup B_{S_i^2}\right),1\}}+\frac{s\left(C_{S_i^1}\backslash C_{S_i^2}\right)+s\left(C_{S_i^2}\backslash C_{S_i^1}\right)}{\max\{s\left(C_{S_i^1}\cup C_{S_i^2}\right),1\}}+\frac{s\left(D_{S_i^1}\backslash D_{S_i^2}\right)+s\left(D_{S_i^2}\backslash D_{S_i^1}\right)}{\max\{s\left(D_{S_i^1}\cup D_{S_i^2}\right),1\}}}}{2}\right]$$

Then, $d_G\left(G_{N_i^1}, G_{N_i^2}\right)$ is called generalized Euclid distance measure for generalized set valued neutrosophic quadruple numbers.

Where, s(A) is the number of element of set A.

## 3. Algorithm For Eases Choice of The Right Operator For a Business By Euclidean Measures on Generalized Set Valued Neutrosophic Quadruple Sets

Whether the business is small or large, their problems are often similar. The root cause of all problems is the operator. If the right operator is chosen, the easier the business will be managed and the more profitable it will be. Choosing the right operator is not easy. Here, an algorithm is introduced to facilitate our decision to select the right operator. This algorithm is based on the Euclidean similarity measure on generalized set-valued neutrophic quadruple sets. In this chapter we used the algorithm in [27] and Euclidean similarity measure on generalized set-valued neutrophic quadruple sets in [27].

**Algorithm 3.1:** It is an algorithm that will show how right an operator has been chosen. First, the set of skills required for each operator is determined. Then, weight values are given according to the importance of these skills. In order to facilitate our recruitment, an ideal set of criteria is determined for the skills that the right operator should have. The criteria owned by the operators are expressed in sets of neutrophic quadruples. The criteria of each operator are given in a table. The Euclidean similarity measure, which is based on the generalized set-valued neutrophic quadruples, is used to find out how similar the criteria each operator has for each skill is to the ideal criterion. The values obtained with this measure are multiplied by the weight values of the skills. The values obtained for



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each of these weighted skills obtained for each operator are summed up, and the decision of the operators is made.

**Step 1:** Let the set of desired skills of an operator be $B = \{b_1, b_2, \dots, b_m\}$ .

**Step 2:** Let the set of the weight values of the skills according to their importance be $U = \{u_1, u_2, \dots, u_m\}$ .

In other words;

weight value of the skill $b_1$ is $u_1$,

weight value of the skill $b_2$ is $u_2$,

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.

weight value of the skill $b_m$ is $u_m$ .

Also, $\sum_{i=1}^{m} u_i = 1$ .

**Step 3:**

For the generalized set-valued neutrosophic quadruple number

$L = \{b_1: (P(G), P(G)T_{1j}, \emptyset I_{1j}, \emptyset F_{1j}), b_2: (P(R), P(R)T_{2j}, \emptyset I_{2j}, \emptyset F_{2j}), \dots, b_m: (P(Q), P(Q)T_{mj}, \emptyset I_{mj}, \emptyset F_{mj})\}$

,

the set of decision that must be given for the condition $P(G)$ of the skill $b_1$, the set of decision that must be given for the situation ( $P(G)T_{1j}, \emptyset I_{1j}, \emptyset F_{1j}$),

the set of decision that must be given for the condition $P(R)$ of the skill $b_2$, the set of decision that must be given for the situation ( $P(R)T_{2j}, \emptyset I_{2j}, \emptyset F_{2j}$) ,

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the set of decision that must be given for the condition $P(Q)$ of the skill $b_m$, the set of decision that must be given for the situation ( $P(Q)T_{mj}, \emptyset I_{mj}, \emptyset F_{mj}$), and let $G = \{g_1, g_2, \dots, g_m\}$, $R = \{r_1, r_2, \dots, r_m\}$,…, $Q = \{q_1, q_2, \dots, q_m\}$ be the sets of the final decisions. Take

$T_{1j} = T_{2j} = \cdots = T_{mj} = 1$



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$I_{1j} = I_{2j} = \cdots = I_{mj} = 0$

$F_{1j} = F_{2j} = \cdots = F_{mj} = 0$ .

Let $S$ be our ideal set.

**Step 4:**

Let the set of operators be $I = \{I_1, I_2, \dots, I_m\}$. Let us express the decision for each operator in this set by a set-valued neutrosophic quadruple.

$I_1 = \{b_1: (G_{11}, G_{12}T_{11}, G_{13}I_{11}, G_{14}F_{11}), b_2: (R_{11}, R_{12}T_{12}, R_{13}I_{12}, R_{14}F_{12}), \dots,$

$b_m: (Q_{11}, Q_{12}T_{1m}, Q_{13}I_{1m}, Q_{14}F_{1m})\}$

$I_2 = \{b_1: (G_{21}, G_{22}T_{21}, G_{23}I_{21}, G_{24}F_{21}), b_2: (R_{21}, R_{22}T_{22}, R_{23}I_{22}, R_{24}F_{22}), \dots,$

$b_m: (Q_{21}, Q_{22}T_{2m}, Q_{23}I_{2m}, Q_{24}F_{2m})\}$

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$I_j = \{b_1: (G_{j1}, G_{j2}T_{j1}, G_{j3}I_{j1}, G_{j4}F_{j1}), b_2: (R_{j1}, R_{j2}T_{j2}, R_{j3}I_{j2}, R_{j4}F_{j2}), \dots,$

$b_m: (Q_{j1}, Q_{j2}T_{jm}, Q_{j3}I_{jm}, Q_{j4}F_{jm})\} \quad , \quad j = 1,2, \dots, m$

are all evaluated seperately.

Here,

$G_{11}, G_{12}, G_{13}, G_{14}, G_{21}, G_{22}, G_{23}, G_{24}, \dots, G_{j1}, G_{j2}, G_{j3}, G_{j4} \in P(G)$

$R_{11}, R_{12}, R_{13}, R_{14}, R_{21}, R_{22}, R_{23}, R_{24}, \dots, R_{j1}, R_{j2}, R_{j3}, R_{j4} \in P(R)$

.

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$Q_{11}, Q_{12}, Q_{13}, Q_{14}, Q_{21}, Q_{22}, Q_{23}, Q_{24}, \dots, Q_{j1}, Q_{j2}, Q_{j3}, Q_{j4} \in P(Q)$ .

**Step 5:** Denote the criteria of the skills that the operators have with generalized set-valued neutrosophic quadruples in a table.

**Table 1.** Representation of the criteria that the operators have according to the skills they should have

| | $b_1$ | $b_2$ | $\cdots$ | $b_m$ |
|---|---|---|---|---|



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| | | | | |
|---|---|---|---|---|
| $I_1$ | $(G_{11}, G_{12}T_{11}, G_{13}I_{11}, G_{14}F_{11})$ | $(R_{11}, R_{12}T_{12}, R_{13}I_{12}, R_{14}F_{12})$ | … | $(Q_{11}, Q_{12}T_{1m}, Q_{13}I_{1m}, Q_{14}F_{1m})$ |
| $I_2$ | $(G_{21}, G_{22}T_{21}, G_{23}I_{21}, G_{24}F_{21})$ | $(R_{21}, R_{22}T_{22}, R_{23}I_{22}, R_{24}F_{22})$ | … | $(Q_{21}, Q_{22}T_{2m}, Q_{23}I_{2m}, Q_{24}F_{2m})$ |
| .<br>.<br>. | .<br>.<br>. | .<br>.<br>. | …<br>…<br>… | .<br>.<br>. |
| $I_j$ | $(G_{j1}, G_{j2}T_{j1}, G_{j3}I_{j1}, G_{j4}F_{j1})$ | $(R_{j1}, R_{j2}T_{j2}, R_{j3}I_{j2}, R_{j4}F_{j2})$ | … | $(Q_{j1}, Q_{j2}T_{jm}, Q_{j3}I_{jm}, Q_{j4}F_{jm})$ |

**Step 6:** Calculate the Euclidean similarity measure of each skill of each operator in Table.1 with the ideal set.

**Table 2.** Table of the Euclidean similarity measure between the skills of the operators and the ideal set

| | $b_1$ | $b_2$ | … | $b_m$ |
|---|---|---|---|---|
| $I_1$ | $C_E(L(b_1), I_1(b_1))$ | $C_E(L(b_2), I_1(b_2))$ | … | $C_E(L(b_m), I_1(b_m))$ |
| $I_2$ | $C_E(L(b_1), I_2(b_1))$ | $C_E(L(b_2), I_2(b_2))$ | … | $C_E(L(b_m), I_2(b_m))$ |
| .<br>.<br>. | .<br>.<br>. | .<br>.<br>. | …<br>.<br>. | .<br>.<br>. |
| $I_j$ | $C_E(L(b_1), I_j(b_1))$ | $C_E(L(b_2), I_j(b_2))$ | … | $C_E(L(b_m), I_j(b_m))$ |

**Step 7:** Multiply the similarity measure in Table 2 with the weight value in the k-th column ($k$=1,2,…,$m$). In Table 3, the similarity value of the $j$-th operator to the ideal set is measured by $C_{Ej}(L, I_j) = \sum_{k=1}^{m} u_k \,.\, C_E(L(b_k), I_j(b_k))$ .



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**Table 3.** Table of weighted similarity of the operators and the ideal set

| | $u_1 b_1$ | $u_2 b_2$ | … | $u_m b_m$ | $\sum_{k=1}^{m} u_k \,.\, C_E$ $(L(b_k),$ $I_j(b_k))$ |
|---|---|---|---|---|---|
| $I_1$ | $u_1 . C_E(L$ $(b_1),$ $I_1(b_1))$ | $u_2 . C_E(L$ $(b_2),$ $I_1(b_2))$ | … | $u_m . C_E(L($ $b_m),$ $I_1(b_m))$ | $C_{E1}(L, I_1)$ |
| $I_2$ | $u_1 . C_E(L$ $(b_1),$ $I_2(b_1))$ | $u_2 . C_E(L$ $(b_2),$ $I_2(b_2))$ | … | $u_m . C_E(L($ $b_m),$ $I_2(b_m))$ | $C_{E2}(L, I_2)$ |
| . . . | . . . | . . . | … . . | . . . | . . . |
| $I_j$ | $u_1 . C_E(L$ $(b_1),$ $I_j(b_1))$ | $u_2 . C_E(L$ $(b_2),$ $I_j(b_2))$ | … | $u_m . C_E(L($ $b_m),$ $I_j(b_m))$ | $C_{Ej}(L, I_j)$ |

**Example 3.2:** First, the set of skills is determined. The weight values of these skills, that is, the importance of each skill, are determined. The ideal set of criteria of the skills that an operator has to have is given. Here, ideal set is defined as our ideal criteria set. In order to give final decisions, the set of the operators is determined. The criteria that the operators meet are written as generalized set-valued neutrophic quadruple numbers for each operator. A table is formed to show the criteria of each skill for each operator. The similarity value between the skills that these operators have and the ideal skills is calculated. This similarity value obtained is multiplied by the weight value of each skill. Thus, the weighted similarity value is calculated. The similarity values of the skills that the operators have is calculated by adding the weighted similarity values of each operator.

**Step 1:** Let the set of skills be $B =${encouraging people, problem solving, pursuit of change, cooperation}

**Step 2:** Let the weight values of the skills be

0.3 for encouraging people,

0.4 for problem solving



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0.1 for pursuit of change and

0.2 for cooperation.

**Step 3:** For the generalized set-valued neutrosophic quadruple number

$L =$ {encouraging people:({communication skills, motivation},{self-confidence, longsightedness, flexibility}1,∅0, ∅0), problem solving:({planning skills, management skills, longsightedness}, {management skills, time management}1, ∅0, ∅0), pursuit of change:({flexibility, longsightedness}, {self-confidence, financial knowledge, ambitiousness}1, ∅0, ∅0), cooperation:({communication skills, self-confidence, financial knowledge}, {financial knowledge, planning skills, management skills}1, ∅0, ∅0)} ,

the criteria that an operator must have for encouraging people skills {communication skills, motivation}, the must-have criteria considering the situation of the operator and the business ({self-confidence, longsightedness, flexibility}1,∅0, ∅0) ,

for the problem-solving skills { planning, management, longsightedness} the must-have criteria considering the situation of the operator and the business, ({management skills, time management }1,∅0, ∅0) ,

for the pursuit of change {flexibility, longsightedness} the must-have criteria considering the situation of the operator and the business ({self-confidence, financial knowledge, ambitiousness}1,∅0, ∅0) ,

for cooperation {communication skills, self confidence, financial knowledge}, the must-have criteria considering the situation of the operator and the business ({financial knowledge, planning, management skills}1,∅0, ∅0)

and let

$G =${communication skills, motivation, financial knowledge, planning, management skills, self confidence, time management, ambitiousness, flexibility, longsightedness},

$R =${communication skills, motivation, financial knowledge, planning, management skills, self confidence, time management, ambitiousness, flexibility, longsightedness},

$Q =${communication skills, motivation, financial knowledge, planning, management skills, self confidence, time management, ambitiousness, flexibility, longsightedness},

$Z =${communication skills, motivation, financial knowledge, planning, management skills, self confidence, time management, ambitiousness, flexibility, longsightedness}.

**Step 4:** Let $I = \{I_1, I_2, I_3, I_4, I_5, I_6\}$ be the set of operators.

$I_1 =${encouraging people:({motivation, time management}, {financial knowledge, management skills}(0.4), {ambitiousness, flexibility}(0.3),{longsightedness}(0.3)),

problem solving: ({planning, self confidence},{communication skills, time management}(0.2),{longsightedness, motivation}(0.3),{ambitiousness, flexibility} (0.5)),



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pursuit for change: ({flexibility},{financial knowledge, communication skills}(0.5), {management skills, self confidence}(0.1),{communication skills, financial knowledge}(0.4)),
cooperation: ({self confidence},{financial knowledge}(0.2),{planning, motivation}(0.3),{communication skills, flexibility}(0.5))}

$I_2$ ={encouraging people:({financial knowledge}, {motivation, communication skills}(0.3), {self confidence, planning, financial knowledge}(0.3),{flexibility, longsightedness}(0.4)),
problem solving: ({time management, planning},{financial knowledge, self confidence} (0.4), {motivation, flexibility}(0.5), {financial knowledge, time management, planning}(0.1)),
pursuit for change: ({longsightedness},{self confidence, planning}(0.5), {time management}(0.2), {longsightedness, ambitiousness}(0.3)),
cooperation: ({financial knowledge, flexibility, communication skills},{management skills, longsightedness}(0.7), {flexibility, time management}(0.2), {communication skills}(0.1))}

$I_3$ ={encouraging people:({management skills, financial knowledge, flexibility}, {motivation, time management}(0.6), {planning, flexibility}(0.1), {communication skills}(0.3)),
problem solving: ({planning, self confidence},{financial knowledge, flexibility}(0.4), {time management, financial knowledge}(0.2),{management skills}(0.4)),
pursuit for change: ({planning, flexibility},{communication skills, ambitiousness}(0.2), {ambitiousness, flexibility}(0.6), {financial knowledge, self confidence}(0.2)),
cooperation: ({management skills, flexibility},{self confidence, longsightedness}(0.8), {communication skills}(0.1),{planning}(0.1))}

$I_4$ ={encouraging people:({longsightedness, motivation, communication skills}, {motivation, self confidence}(0.3), {communication skills, financial knowledge}(0.4), {planning, ambitiousness}(0.3)),
problem solving: ({planning, self confidence},{communication skills, time management}(0.2), {ambitiousness, planning}(0.7), {management skills}(0.1)),
pursuit for change: ({time management, ambitiousness}, {longsightedness, management skills, financial knowledge}(0.8), {self confidence}(0), {financial knowledge, planning}(0.2)),
cooperation: ({financial knowledge, time management}, {communication skills}(0.5), {flexibility, time management}(0.3), {longsightedness, managemenet skills}(0.2))}

$I_5$ ={encouraging people:({planning, flexibility}, {motivation, time management}(0.4), {flexibility, ambitiousness}(0.6), {financial knowledge, planning}(0)),
problem solving: ({management skills, time management}, {planning, financial knowledge} (0.5), {communication skills, self confidence}(0.1), {longsightedness, flexibility}(0.4)),
pursuit for change: ({flexibility, ambitiousness}, {longsightedness, self confidence, planning}(0.7), {management skills, self confidence, financial knowledge}(0.1), {time management, ambitiousness}(0.2)),



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cooperation: ({longsightedness, financial knowledge}, {communication skills, management skills}(0.6), {flexibility, self confidence}(0.2), {planning, communication skills}(0.2))}

$I_6$ ={encouraging people:({management skills, motivation}, {communication skills, longsightedness}(0.8), {financial knowledge, flexibility}(0.1), {planning, self confidence}(0.1)),
problem solving: ({longsightedness, financial knowledge, management skills}, {motivation, time management, longsightedness}(0.6), {self confidence, ambitiousness}(0.4), {financial knowledge, time management, planning}(0)),
pursuit for change: ({communication skills, management skills}, {financial knowledge, self confidence, flexibility}(0.4), {time management, self confidence}(0.4), {ambitiousness, management skills, motivation}(0.2)),
cooperation: ({motivation, planning, communication skills}, {financial knowledge, longsightedness, motivation}(0.7), {planning, management skills}(0.1), {ambitiousness, flexibility}(0.2))}

**Step 5:** In Table 4, we denote the criteria of the skills that the operators have.

**Table 4.** Skills of the operators

| | encouraging people | problem solving | pursuit for change | cooperation skills |
|---|---|---|---|---|
| $I_1$ | ({motivation, time management}, {financial knowledge, management skills}(0.4), {ambitiousness, flexibility}(0.3), {longsightedness}(0.3)) | ({planning, self confidence}, {communication skills, time management}(0.2), {longsightedness, motivation}(0.3), {ambitiousness, flexibility} (0.5)) | ({flexibility},{financial knowledge, communication skills}(0.5), {management skills, self confidence}(0.1), {communication skills, financial knowledge}(0.4)) | ({self confidence}, {financial knowledge}(0.2), {planning, motivation} (0.3), {communication skills, flexibility}(0.5))} |
| $I_2$ | ({financial knowledge}, {motivation, communi | ({time management, planning}, {financial | ({longsightedness},{self confidence, planning | ({financial knowledge, flexibility, commu |



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| | | | | |
|---|---|---|---|---|
| | cation skills} (0.3), {self confidence, planning, financial knowledge}(0.3), {flexibility, longsightedness}(0.4)) | knowledge, self confidence} (0.4), {motivation, flexibility} (0.5), {financial knowledge, time management, planning}(0.1)) | }(0.5), {time management}(0.2), {longsightedness, ambitiousness}(0.3)), | nication skills}, {management skills, longsightedness}(0.7), {flexibility, time management} (0.2), {communication skills}(0.1))} |
| $I_3$ | ({management skills, financial knowledge, flexibility}, {motivation, time management}(0.6), {planning, flexibility}(0.1), {communication skills}(0.3)) | ({planning, self confidence}, {financial knowledge, flexibility}(0.4), {time management, financial knowledge} (0.2), {management skills} (0.4)) | ({planning, flexibility}, {communication skills, ambitiousness}(0.2), {ambitiousness, flexibility}(0.6), {financial knowledge, self confidence}(0.2)) | ({management skills, flexibility},{self confidence, longsightedness}(0.8), {communication skills}(0.1), {planning}(0.1))} |
| $I_4$ | ({longsightedness, motivation, communication skills}, {motivation, self confidence}(0.3), {communication skills, financial knowledge}(0.4), {plannin | ({planning, self confidence}, {communication skills, time management}(0.2), {ambitiousness, planning}(0.7), {management skills}(0. | ({time management, ambitiousness}, {longsightedness, management skills, financial knowledge} (0.8), {self confidence}(0), {financia | ({financial knowledge, time management}, {communication skills}(0.5), {flexibility, time management}(0.3), |



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| | | | | |
|---|---|---|---|---|
| | g, ambitious ness}(0.3 )) | 1)) | l knowled ge, planning }(0.2)) | {longsi ghtedne ss, manage menet skills}( 0.2))} |
| $I_5$ | ({plannin g, flexibility }, {motivati on, time managem ent}(0.4), {flexibilit y, ambitious ness}(0.6 ), {financia l knowledg e, planning }(0)) | ({manag ement skills, time manage ment}, {plannin g, financial knowled ge} (0.5), {commu nication skills, self confiden ce}(0.1), {longsig htedness, flexibilit y}(0.4)) | ({flexibil ity, ambitiou sness}, {longsig htedness, self confiden ce, planning }(0.7), {manage ment skills, self confiden ce, financial knowled ge}(0.1), {time manage ment, ambitiou sness}(0. 2)) | ({longs ightedn ess, financi al knowle dge}, {comm unicati on skills, manage ment skills}( 0.6), {flexibi lity, self confide nce}(0. 2), {planni ng, commu nicatio n skills}( 0.2))} |
| $I_6$ | ({manage ment skills, motivatio n}, {commu nication skills, longsight edness}( 0.8), {financia l knowledg e, flexibility }(0.1), {plannin g, self confidenc e}(0.1)) | ({longsig htedness, financial knowled ge, manage ment skills}, {motivati on, time manage ment, longsight edness}( 0.6), {self confiden ce, ambitiou sness}(0. 4), {financia l | ({commu nication skills, manage ment skills}, {financia l knowled ge, self confiden ce, flexibilit y}(0.4), {time manage ment, self confiden ce}(0.4), {ambitio usness, manage | ({motiv ation, plannin g, commu nicatio n skills}, {financ ial knowle dge, longsig htednes s, motivat ion}(0. 7), {planni ng, manage ment skills}( |



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| | | | | |
|---|---|---|---|---|
| | | knowledge, time management, planning}(0)) | ment skills, motivation}(0.2)) | 0.1), {ambitiousness, flexibility}(0.2))} |

**Step 6:** We calculate the Euclidean similarity value of each skill of each operator in Table 5 with respect to the ideal set.

**Table 5.** Table of Euclidean similarity between the skills of the operators and the ideal set

| | encouraging people | problem solving | pursuit for change | cooperation |
|---|---|---|---|---|
| $I_1$ | 0,3435 | 0,2712 | 0,3826 | 0,3327 |
| $I_2$ | 0,2666 | 0,3158 | 0,3656 | 0,4493 |
| $I_3$ | 0,3666 | 0,3158 | 0,2712 | 0,4333 |
| $I_4$ | 0,3276 | 0,2712 | 0,4459 | 0,3492 |
| $I_5$ | 0,3000 | 0,3492 | 0,4345 | 0,3989 |
| $I_6$ | 0,4712 | 0,4159 | 0,3126 | 0,4256 |

**Step 7:** Now, we multiply the similarity measure values in Table 5 with the weight values in the *k*-th column (*k*=1,2,…,*m*). In Table 6, we derive the similarity between the criteria of already-had and must-have skills of an operator by adding the weighted similarity values for each operator.

**Table 6.** Weighted similarity table between the already-had and must have skills of the operators

| | (0,3). encouraging people | (0,4). problem sol | (0,1). pursuit for | (0,2). cooperation | $\sum_{k=1}^{4} u_k . C_E(L(b_k),I_j(b_k))$ |
|---|---|---|---|---|---|



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| | | vin g | ch an ge | | |
|---|---|---|---|---|---|
| $I_1$ | 0,1030 | 0,1084 | 0,0382 | 0,0665 | $C_{E1}(L, I_1) = 0{,}3161$ |
| $I_2$ | 0,0799 | 0,1263 | 0,0365 | 0,0898 | $C_{E2}(L, I_2) = 0{,}3325$ |
| $I_3$ | 0,1099 | 0,1263 | 0,0271 | 0,0866 | $C_{E3}(L, I_3) = 0{,}3499$ |
| $I_4$ | 0,0982 | 0,1084 | 0,0445 | 0,0698 | $C_{E4}(L, I_4) = 0{,}3209$ |
| $I_5$ | 0,0900 | 0,1396 | 0,0434 | 0,0797 | $C_{E5}(L, I_5) = 0{,}3527$ |
| $I_6$ | 0,1413 | 0,1663 | 0,0312 | 0,0851 | $C_{E6}(L, I_6) = 0{,}4239$ |

$$I_6 > I_5 > I_3 > I_2 > I_4 > I_1$$

So, the similarity value of the criteria of each operator was calculated. The operator $I_6$ has the closest value of criteria among the essential criteria for the desired skills with 0,4239.

**4. Conclusion**

In this study, an algorithm that is designed to facilitate the choice of the right people to manage a business is introduced. This algorithm can calculate the value of the criteria that each of the operators has for each skill that they should have, accordingly, it allows us to choose the operators fairly and easily by looking at the similarity between the criteria that they are required to have. An example is given in order to make it more understandable. In this example, we can take the desired skills and criteria as many as we want and change them as desired. In addition, this algorithm, which has been prepared for the selection of business operators, can be used in other professions and in other elections, and as many people, skills, and criteria can be selected as desired.

**Abbreviations**

NQN: Neutrosophic quadruple number

NQS: Neutrosophic quadruple set

SVNQN: Set-valued neutrosophic quadruple number

SVNQS: Set-valued neutrosophic quadruple set



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GNQN: Generalized neutrosophic quadruple number

GSVNQN: Generalized set-valued neutrosophic quadruple number

GSVNQS: Generalized set-valued neutrosophic quadruple set

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