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Hybrid Intuitionistic Fuzzy Set-TOPSIS With A New Similarity Formula: Non-Medical Healing Factors of Covid-19 Patients

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Abstract. The formula of similarity measure by Yafie Song et al. is one of the many formulas that have been developed by previous authors. Numerically, it is better than other formulas. In this article, we proposed a hybrid Intuitionistic Fuzzy Set (IFS)-TOPSIS method by using the similarity measure of Yafie Song. Then, we used the method to determine the most influential non-medical healing factors of Covid-19 patients using that method as case study. The subject of this research is Covid-19 patients in East-Java, Indonesia. Our result showed that "one-house family" is the most influential factor of the non-medical healing for Covid-19 patients.

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1. Introduction

Many studies have been conducted on the application of fuzzy concepts, some of which are: Muthukumar [1] examined Intuitionistic Fuzzy Set (IFS) similarity and its application in medical diagnosis; Cagman [2, 3] examined the application of soft matrices in decision making; Yang [4] examined the application of soft matrices; Rajarajeswari [5], Sarala [6], and Gandhimati [7] studied the application of intuitive fuzzy soft matrix theory in medical diagnosis; Sulaiman et al. [8] proposed application of Weighted Similarity on Intuitionistic Fuzzy Soft Matrices in Medical Diagnostics, Kozea [9] studied the application of intuitionistic fuzzy set in Covid-19, Xin-Bau Gu [10] studied the Application of Intuitionistic Fuzzy Set-TOPSIS Model on The Level Assesment of the Surrounding Rocks, Vennila R examined the application of intuitionistic fuzzy set in business trips, Muthuraj [11] studied application of intuitionistic mult-fuzzy set in crop selection, and many others.

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There are also many studies conducted by experts on Covid-19 using various methods, one of which is using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method or fuzzy TOPSIS. In previous studies, the intuitive fuzzy TOPSIS method was introduced by Boran [12], Rouyendegh [13, 14], and Tlig and Rebai [15], while Astuti et al. [16] used an intuitive fuzzy TOPSIS with a distance Euclid to determine the dominant factors that affect the resistance of Covid-19 patients. As we know, the concept of similarity is complementary to the concept of distance. The larger the measure of the distance of the two IFS means the smaller the measure of the similarity of them.

Corona Virus Disease-19 (Covid-19), which was initially a pandemic, has now become an Endemic. On March 11 2020, World Health Organization (WHO) stated that Covid-19 has entered a new phase where the number of sufferers continues to decline. Even though the appearance of the last variant, namely Omicron, was detected in early 2022, this variant is not so fatal in confirmed patients. This is probably due to the fact that people are starting to become immune to various variants of the Covid-19 virus and many people have received the second and booster vaccines. Seeing the condition, several countries in Asia have begun to set status from pandemic to endemic for Covid-19. By changing the status from pandemic to endemic, the discussion is no longer aimed at determining the model of virus spread, but researchers are starting to focus their research on analysing the effect of various treatments through various method of effectiveness tests. The treatment applied to the community to deal with virus includes a healthy lifestyle, orderly wearing mask, diligently washing hands, social distancing, and receiving complete vaccines. Ernawati [17] said there are factors that influence Covid patients, namely fear and stigma. She investigated the fear and stigma of COVID-19-related factors among the general population while Saul G.A [18] discussed about Covid-19 and adverse social determinants of health.

Several researchers have also focused on the effectiveness of handling Covid-19 in medical and non-medical factor. This research will focused on the resilience of Covid-19 to non-medical factors. The factors that affect the resilience of Covid-19 patients to be able to survive from the virus Covid-19 in their bodies are supported by various factors. Apart from medical factors, non-medical factors also play an important role in supporting the patient's recovery. These non-medical factors are often supported by the patient's social environment. It could be from the family living in the same house, families who do not live in the same house, the environment around the house, for example neighbours or the health-centre around the house, the work or school environment.

Many measures of similarity have been developed between the two of IFSs, namely the measure that have been constructed by Chen [19], Hong and Kim [20], Li and Xu [21], Dengfeng and Chuntian [22], Liang and Shi [23], and Ye, Boran and Akay [24]. Yafie Song [25] then developed a new similarity measure. He compared his measure with various existing ones. It was proven that his similarity measure was numerically finer than the previous ones. This is the reason why this article used Yafi's new similarity measure. For that reason, this research will developed the IFS-TOPSIS method with the new similarity measure.

The main objective of this article is to propose the method which can be used to determine the most influential non-medical healing factors for surviving from Covid-19 disease. It may become the dominant factors affecting the resilience of Covid-19 patients, in which we called them as a set of four alternatives. These are: one-house family (A_1), the family does not live in the same house (A_2), neighbour (A_3), and co-workers or schoolmates (A_4). The method used in this research is a hybrid of Intuitionistic Fuzzy Set (IFS) concept and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) using the similarity measure. It is applied for Covid-19 patients in East Java, Indonesia. This study will determines the dominant factors that affect the resilience of Covid-19 patients. The criteria for determining the dominant alternative include: 1) Provide necessary supplements in the form of vitamins and medicines, multi vitamins, eucalyptus oil, and balm (C_1); 2) Provide staple food needs including rice, side dishes, vegetables, fruit, and milk (C_2); 3) Provide religious spiritual support, for example sending or guiding to recite prayers for healing (C_3); 4) Provide non-spiritual support, for example sending songs/videos to entertain, invite to chat, show concern, ask news, and so on (C_1). The weight of each criterion is obtained by questionnaires or direct interviews with respondents those who have suffered from Covid-19 and recovered. At the end of this research, it is hoped that the dominant factors of the alternatives determined in supporting the recovery of Covid-19 patients are known. This information is important for the provision of families or other parties in dealing with Covid-19 patients or other similar conditions that may occur in the future.

2. Intuitionistic Fuzzy Set (IFS): Basic concepts

Before proceeding to describe TOPSIS method, we briefly introduce some necessary introductory concepts of IFS. As a basis for the discussion, this section describes the notion of fuzzy sets, then expands them into intuitionistic fuzzy sets. The definition of fuzzy set was first introduced by Zadeh [26] in 1965, then expanded to an intuitionistic fuzzy set by Atanassov [27] in 1986. The following describes these two definitions.

Definition 1. *(see [26]). Let* $X = \{x_1, x_2, x_3, ..., x_n\}$ *be a crisp set. A fuzzy set (FS) of* X *is defined as a set of ordered pair* $B = \{(x, \mu_B(x)) : x \in X\}$*,where* $0 \leq \mu_B(x) \leq 1$*, for all* $x \in X$*. The function* μ_B *is called the membership function or grade of membership of* x *in* B*.*

Example 1. *Let* $X = \{p, q, r, s\}$*. The set* $B = \{(p, 0.4), (q, 0.7), (r, 0.1), (s, 0.8)\}$ *is the an example of fuzzy set of* X*.*

The concept of fuzzy sets was further expanded by Atanassov to become the concept of intuitionistic fuzzy sets (IFS). In 1983, he generalized the concept of fuzzy sets to an intuitionistic fuzzy set (IFS). The following gives the definition and example.

Definition 2. *(see [26]). Let* $X = \{x_1, x_2, x_3, ..., x_n\}$ *be a crisp set. An intuitionistic fuzzy set (IFS) of* X *is defined as* $\mathcal{B} = \{(x, \mu_B(x), v_B(x)) : x \in X\}$*,where:* $0 \leq \mu_B(x) \leq 1, 0 \leq v_B(x) \leq 1$*, and* $0 \leq \mu_B(x) + v_B(x) \leq 1$*, for all* $x \in X$*.*

The function μ_B and v_B are called the membership and the non-membership function respectively. The amount $\pi_B(x) = 1 - \mu_B(x) - v_B(x)$ is called the degree of indeterminacy or hesitation part. Furthermore, we call $< \mu_B(x), v_B(x), \pi_B(x) >$ by Intuitionistic Fuzzy Number (IFN) of x.

Example 2. *Let $X = \{p, q, r\}$. The set $B = \{(p, 0.5, 0.3), (q, 0.6, 0.3), (r, 0.2, 0.8)\}$ is the an example of fuzzy set of X.*

3. The New Similarity Measure of IFS

Many researchers have constructed similarity measure of IFS. The following, several similarity measure that have been developed are presented.

Let $X = \{x_1, x_2, x_3, ..., x_n\}$. $A, B \in IFS(X)$ with $\mathcal{A} = \{(x, \mu_A(x), v_A(x)) : x \in X\}$ and $\mathcal{B} = \{(x, \mu_B(x), v_B(x)) : x \in X\}$.

a). Chen [19] constructed the formula of measure similarity as:

$$S_C(AB) = 1 - \tfrac{1}{2n} \textstyle\sum_{j=1}^{n} |\mu_A(x_i) - v_A(x_i) - (\mu_B(x_i) - v_B(x_i))|$$

b). Hong and Kim [20] proposed the following to overcome the deficiency that Chen has proposed.

$$S_H(AB) = 1 - \tfrac{1}{2n} \textstyle\sum_{j=1}^{n} |\mu_A(x_i) - \mu_B(x_i) - (v_A(x_i) - v_B(x_i))|$$

c). Li and Xu [21] proposed the similarity measure:

$$\begin{aligned} S_H(AB) = 1 - \frac{1}{4n} \sum_{j=1}^{n} |\mu_A(x_i) - v_A(x_i) - (\mu_A(x_i) - v_B(x_i))| \\ - \frac{1}{4n} \sum_{j=1}^{n} |\mu_A(x_i) - \mu_B(x_i)| + |v_A(x_i) - v_B(x_i)|. \end{aligned}$$

Furthermore, others similarity measures have been constructed by Li et al [28], Dengfeng and Chuntian [22], Mitchell [29], Liang and Shi [23], Hung and Yang [30], Ye [31], Boran and Akay [24]. Most of the existing similarity measure for IFS have counterintuitive results. Therefore, Yafi Song etc. [25] proposed the new similarity measure. They constructed the new formula of similarity measure of IFS as shown below:

$$\tfrac{1}{2n} \textstyle\sum_{j=1}^{n} w_i \left(\sqrt{\mu_A(x_i)\, \mu_B(x_i)} + 2\sqrt{v_A(x_i)\, v_B(x_i)} + \sqrt{\pi_A(x_i)\, \pi_B(x_i)} + \sqrt{(1 - v_A(x_i))(1 - v_B(x_i))} \right)$$

where $w_i \in [0, 1]$, $\sum_{j=1}^{n} w_i = 1$. The w_i is the weight factor of the features x_i. This similarity measure is comparable and more transparent with the measure proposed earlier. For that reason, we used the formula in this article.

4. The Hybrid IFS-TOPSIS Method

The multi-criterion decision making (MCDM) is one of many research areas involving the analysis of various available choices in a situation or research area which spans daily life, medicine, engineering, social sciences, and many other areas. Some of the MCDM methods often used are ANP (Analytic Network Process), AHP (Analytic Hierarchy Process), and TOPSIS (Technique for Order Preference by Similarity to Ideal Solution).

TOPSIS was firstly introduced in 1981 by Hwang and Yoon [32]. It is a method based on the selection criterion. TOPSIS can be used for selection by considering both positive and negative criteria. The basic idea of this method is to make a ranking of the existing alternatives. The ranking is made from the best to the worst. The best solution among the alternatives in the obtained order is the closest one to the positive ideal solution at the same time as the farthest negative solution.

In this article, we explain how to determine the most influencing survival factor of Covid-19 patients by using a hybrid IFS-TOPSIS method with the new similarity formula. The new formula meant is the similarity formula of Yafie Song as described above.

In this section, we present the hybrid method, intuitionistic fuzzy set and TOPSIS. The evaluation of the study based on this hybrid is described below.
Let $A = \{\ A_1, A_2, ..., A_m\}$ be a set of alternatives and $X = \{\ x_1, x_2, ..., x_n\}$ be a set of criteria. The IFS-TOPSIS algorithm is as follows:

Step 1. Determine the weights of the decision maker (DM).

In this research, the number of decision maker is 113. They are the respondents who have answered the questionnaire survey via google-form or by direct interviews. The importance levels of the decision makers are considered based on linguistic term, that are: Very Very Important (VVI),Very Important (VI), Important (I), Medium (M), Unimportant (UI), Very Unimportant (VUI). Then, the linguistic terms are assigned Intuitionistic Fuzzy Number (IFN) and we write them as D_k. The importance levels of the decision makers in the IFN are shown in Table 1 below.

Table 1: Important level Criteria of the decision makers and IFN's

Important Level Criteria	IFN's (D_k)
Very Very Important (VVI)	(0.9,0.1,0)
Very Important (VI)	(0.7,0.2,0.1)
Important (I)	(0.6,0.3,0.1)
Medium (M)	(0.5,0.4,0.1)
Unimportant (UI)	(0.3,0.5,0.2)
Very Unimportant (VUI)	(0.2,0.8,0)

Let $D_k = \{\mu_k, v_k, \pi_k\}$ be an intuitionistic fuzzy number for the rating of k-th DM. Then, the weight of k-th DM can be calculated as,

$$\lambda_k = \frac{(\mu_k + \pi_k(\frac{\mu_k}{\mu_k+v_k})}{\sum_{k=1}^{l}(\mu_k + \pi_k(\frac{\mu_k}{\mu_k+v_k}))}. \tag{1}$$

where $\lambda_k \in [0,1]$ and $\sum_{k=1}^{l} \lambda_k = 1$.

Step 2. Calculation of the weight of each criterion.

Each respondent filled in the weight of each criterion's assessment in weights of 1, 2, 3, 4, 5. Then the weight is changed to the level of importance in the IFN as shown in Table 2 below.

Table 2: Important level Criteria of the decision makers and IFN's

Response scale	Important level Criteria	IFN's (D_k)
5	Very Important (VI)	(0.9,0.1,0)
4	Important (I)	(0.75,0.2,0.05)
3	Medium (M)	(0.5,0.45,0.05)
2	Unimportant (UI)	(0.35,0.6,0.05)
1	Very Unimportant (VUI)	(0.1,0.9,0)

The weight of each criterion is calculated using the following formula.

$$\begin{aligned} W_j &= IFWAr_\lambda({W_j}^{(1)}, {W_j}^{(2)}, {W_j}^{(3)}, \ldots, {W_j}^{(l)}) \\ &= \lambda_1 {W_j}^{(1)} \bigoplus \lambda_2 {W_j}^{(2)} \bigoplus \lambda_3 {W_j}^{(3)} \bigoplus \ldots \bigoplus \lambda_l {W_j}^{(l)} \\ &= \left[1 - \prod_{k=1}^{l} (1 - {\mu_j}^{(k)})^{\lambda_k}, \prod_{k=1}^{l} ({v_j}^{(k)})^{\lambda_k}, \prod_{k=1}^{l} ({\gamma_j}^{(k)})^{\lambda_k} \right] \end{aligned} \tag{2}$$

Step 3. Determine The Intuitionistic Fuzzy Decision Matrix.

According to the weights of the Decision Makers, the AIFDM (aggregated intuitionistic fuzzy decision matrix) is calculated by using the IFWA (intuitionistic fuzzy weighted averaging) operator.

Let $R^{(k)} = ({r_{ij}}^{(k)})_{m\times n}$ be an intuitionistic fuzzy decision matrix (IFDM) of each decision maker (DM), where ${r_{ij}}^{(k)} = ({\mu_{ij}}^{(k)}, {v_{ij}}^{(k)}, {\pi_{ij}}^{(k)})$. The aggregated intuitionistic fuzzy decision matrix is

$$R = \begin{pmatrix} r_{11} & r_{12} & r_{13} & \cdots & r_{1m} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & r_{n3} & \cdots & r_{nm} \end{pmatrix}, \text{ where}$$

$$\begin{aligned} r_{ij} &= \mathrm{IFW}\,Ar_\lambda({r_{ij}}^{(1)}, {r_{ij}}^{(2)}, {r_{ij}}^{(3)}, \ldots, {r_{ij}}^{(l)}) \\ &= \sum_{k=1}^{l} \lambda_k {r_{ij}}^{(k)} \end{aligned}$$

$$= \left[1 - \prod_{k=1}^{l}(1-\mu_j{}^{(k)})^{\lambda_k}, \prod_{k=1}^{l}(v_j{}^{(k)})^{\lambda_k}, \prod_{k=1}^{l}(\gamma_j{}^{(k)})^{\lambda_k}\right] \tag{3}$$

$i = 1,2,3,\ldots,m$; $j = 1,2,3,\ldots,n$; m and n represent the number of alternatives and criteria, respectively. Meanwhile, λ_k denotes the weight of the k-th DM.

Step 4. Determine an aggregate matrix of weighted intuitionistic fuzzy decisions.

The aggregated weighed intuitionistic fuzzy decision matrix ($R^{'}$) can be obtained from the multiplication of the intuitionistic fuzzy aggregate matrix (R) and the intuitive fuzzy weight matrix (W), namely

$$R^{'} = R \bigotimes W = [r'_{ij}], \text{ where} \tag{4}$$

$$r'_{ij} = \left(\mu'_{ij}, v'_{ij}, \pi'_{ij}\right)$$
$$\mu'_{ij} = \mu_{ij} * \mu_j$$
$$v'_{ij} = v_{ij} + v_j - v_{ij} * v_j$$
$$\pi'_{ij} = 1 - v_{ij} - v_j - \mu_{ij} \cdot \mu_j + v_{ij}.v_j$$

Step 5. Calculate Intuitionistic fuzzy positive and negative ideal solution.

Let J_1 be benefit criterion and J_2 be cost criterion. The Intuitionistic Fuzzy Positive ideal solution (A^{+}) and the Intuitionistic Fuzzy Negative ideal solution (A^{-}) are calculated as,

$$A^{+} = \left(r_1'^{+}, r_2'^{+}, \ldots, r_n'^{+}\right)$$
$$A^{-} = \left(r_1'^{-}, r_2'^{-}, \ldots, r_n'^{-}\right)$$

where

$$r_j'^{+} = \left(\mu_j'^{+}, v_j'^{+}, \pi_j'^{+}\right), \quad j = 1,2,\ldots,n$$
$$r_j'^{-} = \left(\mu_j'^{-}, v_j'^{-}, \pi_j'^{-}\right), \quad j = 1,2,\ldots,n$$
$$\mu_j'^{+} = \left(\max_i \mu'_{ij} \mid j \in J_1, \min_i \mu'_{ij} \mid j \in J_2\right)$$
$$v_j'^{+} = \left(\min_i v'_{ij} \mid j \in J_1, \max_i v'_{ij}(X_j) \mid j \in J_2\right)$$
$$\mu_j'^{-} = \left(\min_i \mu'_{ij} \mid j \in J_1, \max_i \mu'_{ij} \mid j \in J_2\right)$$
$$v_j'^{-} = \left(\max_i \mu'_{ij} \mid j \in J_1, \min_i \mu'_{ij} \mid j \in J_2\right)$$

Step 6. Determine the separation measures between the alternatives in this paper.

The formula of the measure of similarity proposed by Yafie Song, Wang, Lei, and Sue (2014) is used for measure separation between alternatives on intuitionistic fuzzy set. S^* and S^-, the separation measures of each alternative, are calculated for intuitionistic fuzzy positive ideal and negative ideal solutions, respectively.

$$S^* = 1 - \frac{1}{2n}\sum_{j=1}^{n}\sqrt{\mu'_{ij}\mu'^{*}_{j}} + 2\sqrt{v'_{ij}v'^{*}_{j}} + \sqrt{\pi'_{ij}\pi'^{*}_{j}} + \sqrt{\left(1 - v'_{ij}\right)\left(1 - v'^{*}_{j}\right)} \tag{5}$$

$$S^- = 1 - \frac{1}{2n}\sum_{j=1}^{n}\sqrt{\mu'_{ij}\mu'^{-}_{j}} + 2\sqrt{v'_{ij}v'^{-}_{j}} + \sqrt{\pi'_{ij}\pi'^{-}_{j}} + \sqrt{\left(1 - v'_{ij}\right)\left(1 - v'^{-}_{j}\right)} \tag{6}$$

Step 7. Determine the final ranking.

In the final step, the relative of closeness coefficient of an alternative A_i with respect to the intuitionistic fuzzy positive ideal solution A^+ is defined as follow,

$$C_{i^*} = \frac{s_{i^-}}{S_{i^*+S_{i^-}}}, 0 \leq C_{i^*} \leq 1 \tag{7}$$

Finally, we rank it according to descending order of C_{i^*} to show the measure of relative closeness of each alternative.

5. An Illustrative Case Study

In this paper, the hybrid Intuitionistic Fuzzy Set (IFS)-TOPSIS method was used to determine the most influencing factors of the survival of Covid-19 patients. We call these factors as the alternatives. These are: one-house family (A_1), the family does not live in the same house (A_2), neighbour (A_3), and co-workers or schoolmates (A_4).

The subject of this research were the people who have recovered from Covid-19 and lived in East Java, Indonesia. The number of subjects in this research are 113 people. In this case, all of the subjects were decision maker (DM).

The factors that became the criteria for determining the dominant alternative, include: 1) Provide necessary supplements in the form of vitamins and medicines, multi vitamins, eucalyptus oil, balm (C_1); 2) Provide staple food needs including rice, side dishes, vegetables, fruit, milk (C_2); 3) Provide religious spiritual support, for example sending or guiding to recite prayers for healing (C_3); and4) Provide non-spiritual support, for example sending songs/videos to entertain, invite to chat, show concern, ask news, and so on (C_4). The weight of each criterion was obtained by distributing questionnaires or direct interviews with respondents who have suffered from Covid-19 and recovered.

Below, we use the proposed IFS-TOPSIS method to construct an alternative priority order. To do this, the following steps are taken.

Step 1. Determine the weights of the decision maker (DM).

Before determining the weight of the respondent/ decision maker (DM), we first determined the important level of DM. It was determined by taking into account the age and place of healing (Hospital/Rent House, and others). Furthermore, based on Table 1, the Intuitionistic Fuzzy Number (IFN) for decision makers are given in Table 3.

Table 3: Importance level of DM and IFN's

Age (x)	Place of healing	Importance level of DM	IFN's
$x \geq 50$	Hospital/ Rent House	VVI	(0.9,0.1,0)
$x \geq 50$	Others	VI	(0.7,0.2,0.1)
$40 \leq x < 50$	Hospital/ Rent House	I	(0.6,0.3,0.1)
$40 \leq x < 50$	Others	M	(0.5,0.4,0.1)
x <40	Hospital/ Rent House	UI	(0.3,0.5,0.2)
x <40	Others	VUI	(0.2,0.8,0)

Based on these IFN, the weights of the DM was calculated by using the formula (1) and the result is presented in Table 4. The name of DM is written as numbers.

Table 4: Weight of DM

DM	Importance level of DM	Weight of DM (λ_k)	DM	Importance level of DM	Weight of DM (λ_k)
DM1	VI	0.017849174	DM21	UI	0.006425703
DM2	UI	0.006425703	DM22	UI	0.006425703
DM3	UI	0.006425703	DM23	UI	0.006425703
DM4	UI	0.006425703	DM24	UI	0.006425703
DM5	UI	0.006425703	DM25	UI	0.006425703
DM6	UI	0.006425703	DM26	UI	0.006425703
DM7	UI	0.006425703	DM27	VI	0.017849174
DM8	UI	0.006425703	DM28	UI	0.006425703
DM9	UI	0.006425703	DM29	M	0.012048193
DM10	UI	0.006425703	DM30	UI	0.006425703
DM11	UI	0.006425703	DM31	UI	0.006425703
DM12	UI	0.006425703	DM32	UI	0.006425703
DM13	UI	0.006425703	DM33	M	0.012048193
DM14	UI	0.006425703	DM34	UI	0.006425703
DM15	UI	0.006425703	DM35	M	0.012048193
DM16	UI	0.006425703	DM36	VI	0.017849174
DM17	UI	0.006425703	DM37	UI	0.006425703
DM18	UI	0.006425703	DM38	UI	0.006425703
DM19	UI	0.006425703	DM39	UI	0.006425703
DM20	UI	0.006425703	DM40	UI	0.006425703

DM	Importance level of DM	Weight of DM (λ_k)
DM41	UI	0.006425703
DM42	UI	0.006425703
DM43	UI	0.006425703
DM44	M	0.012048193
DM45	UI	0.006425703
DM46	UI	0.006425703
DM47	UI	0.006425703
DM48	UI	0.006425703
DM49	M	0.012048193
DM50	UI	0.006425703
DM51	UI	0.006425703
DM52	UI	0.006425703
DM53	UI	0.006425703
DM54	UI	0.006425703
DM55	M	0.012048193
DM56	UI	0.006425703
DM57	UI	0.006425703
DM58	UI	0.006425703
DM59	UI	0.006425703
DM60	VI	0.017849174
DM61	VI	0.017849174
DM62	UI	0.006425703
DM63	UI	0.012048193
DM64	UI	0.006425703
DM65	UI	0.006425703
DM66	UI	0.006425703
DM67	UI	0.006425703
DM68	UI	0.006425703
DM69	UI	0.006425703
DM70	UI	0.006425703
DM71	UI	0.006425703
DM72	M	0.012048193
DM73	VI	0.017849174
DM74	VI	0.017849174
DM75	UI	0.006425703
DM76	UI	0.006425703
DM77	M	0.012048193

DM	Important level of DM	Weight of DM (λ_k)
DM78	UI	0.006425703
DM79	UI	0.006425703
DM80	VI	0.017849174
DM81	I	0.024988844
DM82	VI	0.017849174
DM83	VI	0.017849174
DM84	M	0.012048193
DM85	UI	0.006425703
DM86	UI	0.006425703
DM87	UI	0.006425703
DM88	UI	0.006425703
DM89	UI	0.006425703
DM90	UI	0.006425703
DM91	UI	0.006425703
DM92	UI	0.006425703
DM93	UI	0.006425703
DM94	M	0.017849174
DM95	UI	0.006425703
DM96	UI	0.006425703
DM97	M	0.012048193
DM98	M	0.021419009
DM99	UI	0.006425703
DM100	UI	0.006425703
DM101	VI	0.017849174
DM102	UI	0.006425703
DM103	UI	0.006425703
DM104	UI	0.006425703
DM105	UI	0.006425703
DM106	UI	0.006425703
DM107	UI	0.006425703
DM108	UI	0.006425703
DM109	UI	0.006425703
DM110	VI	0.017849174
DM111	I	0.024988844
DM112	UI	0.006425703
DM113	VI	0.017849174

Step 2. Calculation of the weight of each criterion.

In this paper, the criteria are: Provide necessary supplements in the form of vitamins and medicines, multi vitamins, eucalyptus oil, balm (C_1); Provide staple food needs including rice, side dishes, vegetables, fruit, milk (C_2); Provide religious spiritual support, for example sending or guiding to recite prayers for healing (C_3); and Provide non-spiritual support, for example sending songs/videos to entertain, invite to chat, show concern, ask news, and so on (C_4). The importance level and Intuitionistic Fuzzy Number (IFN) are given in Table 2.

The process of calculating the weight of each criteria using the formula (2) , λ_k is presented in Table 4, and IFN in Table 2. The result of the calculation as in Table 5.

Table 5: The weight of Criteria

Weight criteria–i (W_i)	IFN
(W_1)	(0.858860548,0.131705138,0.009434314)
(W_2)	(0.865676829,0.126470704,0.007852467)
(W_3)	(0.867071796,0.128203042,0.004725162)
(W_4)	(0.806749983,0.172034094,0.021215923)

Step 3. Determine The Intuitionistic Fuzzy Decision Matrix.

Intuitionistic fuzzy decision matrix contains an alternative assessment against the criteria that the value is calculated from the assessment of each respondent. Constructing the intuitionistic fuzzy decision matrix is the same as step 2. Calculate the level of importance of the alternatives against the criteria based on each respondent. Each respondent fills in the assessment of each alternative against to the criteria by choice : never, 1-2 times, 3-4 times, or 5 times or more. Furthermore, the assessment of the respondent is changed to the level of importance of the alternative against the criteria that will determine the HFI value as based on Table 6.

Table 6: IFN of importance level of alternative

Alternative level of importance to the criteria	IFN
Very often (VO)	(0.9,0.1,0)
Often (O)	(0.7,0.2,0.1)
Seldom (S)	(0.4,0.5,0,0.1)
Never (N)	(0.1,0.9,0)

The assessment given by each respondent for A_1 against C_1, C_2, C_3 and C_4 is shown as linguistic term (See Table 7).

Table 7: Linguistic terms of A1 for each criteria

DM	A_1			
	C_1	C_2	C_3	C_4
DM1	VO	VO	VO	O
DM2	VO	VO	VO	VO
DM3	O	O	VO	O
DM4	O	O	VO	VO
DM5	N	VO	VO	VO
DM6	VO	VO	VO	VO
DM7	S	VO	VO	S
DM8	VO	VO	VO	VO
DM9	VO	VO	O	O
DM10	VO	VO	O	VO
DM11	VO	VO	VO	VO
DM12	S	VO	VO	VO
DM13	O	VO	O	O
DM14	VO	N	VO	VO
DM15	S	VO	VO	O
DM16	O	O	S	S
DM17	R	N	O	O
DM18	VO	VO	VO	VO
DM19	O	O	S	S
DM20	S	S	VO	VO
DM21	VO	VO	VO	VO
DM22	VO	VO	S	S
DM23	VO	VO	VO	VO
DM24	VO	VO	VO	VO
DM25	O	O	VO	VO
DM26	O	O	VO	VO
DM27	VO	VO	VO	VO
DM28	VO	VO	VO	VO
DM29	N	N	N	N
DM30	S	VO	VO	O
DM31	S	N	N	S
DM32	S	VO	VO	O
DM33	S	O	O	O
DM34	S	S	VO	VO
DM35	VO	VO	VO	VO
DM36	O	VO	VO	VO
DM37	VO	VO	VO	S
DM38	S	VO	VO	VO
DM39	VO	VO	VO	O
DM40	VO	VO	VO	VO

DM	A_1			
	C_1	C_2	C_3	C_4
DM41	S	N	O	S
DM42	VO	O	VO	VO
DM43	VO	VO	VO	VO
DM44	N	S	VO	N
DM45	S	S	VO	VO
DM46	J	VO	O	O
DM47	VO	VO	VO	O
DM48	VO	VO	VO	VO
DM49	O	O	S	O
DM50	O	O	VO	VO
DM51	VO	VO	VO	O
DM52	S	VO	VO	S
DM53	N	N	VO	VO
DM54	VO	VO	VO	VO
DM55	VO	VO	VO	VO
DM56	VO	VO	VO	VO
DM57	VO	VO	S	O
DM58	S	N	O	O
DM59	S	S	VO	VO
DM60	O	VO	VO	VO
DM61	VO	VO	VO	VO
DM62	S	VO	VO	O
DM63	N	N	N	N
DM64	S	VO	VO	VO
DM65	VO	VO	VO	O
DM66	O	O	VO	O
DM67	VO	VO	O	O
DM68	O	N	VO	VO
DM69	S	S	O	S
DM70	VO	VO	O	VO
DM71	S	N	S	N
DM72	VO	VO	VO	VO
DM73	VO	VO	VO	VO
DM74	N	N	N	N
DM75	N	VO	VO	VO
DM76	O	O	VO	VO
DM77	VO	VO	VO	VO
DM78	N	N	N	N
DM79	VO	VO	O	O
DM80	VO	VO	VO	VO

DM	A_1			
	C_1	C_2	C_3	C_4
DM81	N	N	VO	J
DM82	S	O	O	O
DM83	O	S	O	S
DM84	VO	VO	VO	VO
DM85	O	VO	VO	S
DM86	VO	VO	VO	VO
DM87	VO	VO	VO	VO
DM88	O	N	S	S
DM89	S	S	O	O
DM90	VO	VO	VO	VO
DM91	VO	VO	VO	VO
DM92	S	VO	O	VO
DM93	VO	VO	VO	VO
DM94	VO	VO	VO	VO
DM95	S	S	VO	VO
DM96	VO	VO	VO	VO
DM97	S	S	O	O

DM	A_1			
	C_1	C_2	C_3	C_4
DM98	S	S	VO	VO
DM99	S	O	VO	VO
DM100	O	S	O	S
DM101	S	N	O	S
DM102	S	S	N	S
DM103	S	S	O	O
DM104	S	S	O	O
DM105	O	O	VO	VO
DM106	VO	VO	VO	VO
DM107	VO	VO	VO	VO
DM108	VO	VO	VO	O
DM109	S	S	S	S
DM110	VO	VO	VO	VO
DM111	O	VO	VO	VO
DM112	VO	VO	VO	VO
DM113	VO	VO	VO	VO

The entry of Intuitionistic Fuzzy Decision Matrix R is determined by using the formula (3). The entry of the matrix R is shown an Table 8.

Table 8: Entry of Matrix R

Alternatives	C1	C2
A1	(0.76,0.21,0.03)	(0.81,0.17,0.01)
A2	(0.62,0.32,0.06)	(0.66,0.29,0.05)
A3	(0.41,0.53,0.06)	(0.49,0.46,0.05)
A4	(0.56,0.37,0.07)	(0.56,0.39,0.05)

Alternatives	C3	C4
A1	(0.85,0.14,0,01)	(0.82,0.16,0.02)
A2	(0.77,0.18,0.04)	(0.70,0.24,0.06)
A3	(0.56,0.36,0.08)	(0.49,0.42,0.09)
A4	(0.73,0.21,0.06)	(0.66,0.26,0.07)

Step 4. Determine an aggregate matrix of weighted intuitionistic fuzzy decisions.

The weighted intuitionistic fuzzy decision aggregate matrix (R') is obtained from the multiplication of the intuitionistic fuzzy decision matrix (R) in Table 8 and the intuitive fuzzy criteria weight matrix (W) in Table 5, by using the formula (4). The entry of matrix R' is shown in Table 9.

Table 9: Entry of Matrix $R^{'}$

Alternatives	C1	C2
A1	(0.66,0.31,0.03)	(0.7,0.28,0.02)
A2	(0.53,0.59,0.06)	(0.43,0.52,0.05)
A3	(0.41,0.53,0.06)	(0.49,0.46,0.05)
A4	(0.48,0.46,0.06)	(0.49,0.46,0.05)

Alternatives	C3	C4
A1	(0.74,0.25,0.01)	(0.66,0.31,0.03)
A2	(0.49,0.45,0.07)	(0.4,0.52,0.08)
A3	(0.56,0.36,0.08)	(0.49,0.42,0.09)
A4	(0.64,0.31,0.05)	(0.54,0.39,0.07)

Step 5. Calculate Intuitionistic fuzzy positive and negative ideal solution.

Based on Table 9, we get the Intuitionistic fuzzy positive and negative ideal solution as in Table 10.

Table 10: Intuitionistic fuzzy ideal solution

	A^*	A^-
C_1	(0.66,0.31,0.03)	(0.35,0.59,0.06)
C_2	(0.7,0.28,0.02)	(0.43,0.52,0.05)
C_3	(0.74,0.25,0.01)	(0.49,0.45,0.07)
C_4	(0.66,0.31,0.03)	(0.4,0.52,0.08)

Step 6. Determine the separation measures between the alternatives in this paper.

According to Table 9, Table 10, the formula (5) and (6), we obtain the value of S^* and S^- for each alternative as in Table 11.

Table 11: The value of S^*, S^-

Alternatives	S^*	S^-
A_1	0	0.027
A_2	0.004	0.011
A_3	0.027	0
A_4	0.009	0.006

Step 7. Determine the final ranking.

According to the formula (7), we obtain the relative closeness coefficient of an alternative A_i with respect to the intuitionistic fuzzy positive ideal solution S^* as in Table 12.

Table 12: The relative closeness coefficient of each alternative to A^+

Alternatives	C_i^*
A_1	1
A_2	0.743
A_3	0
A_4	0.418

Finally, we rank according to descending order of C_i^* to show the measure of relative closeness of each alternative that are A_1,A_2,A_4,A_3.

6. Conclusion

In this article, we proposed a hybrid Intuitionistic Fuzzy Set (IFS)-TOPSIS Method. We used the new similarity formula from Yafie Song et al. This formula has shown to be numerically better than other formulas. Based on the method, we have determine the most influential non-medical healing factors of Covid-19 patients. We have chosen the alternatives as follows: one-house family, the family does not live in the same house, neighbour, and co-workers or schoolmates. While the criteria are: 1) Provide necessary supplements in the form of vitamins and medicines, multi vitamins, eucalyptus oil, balm; 2) Provide staple food needs including rice, side dishes, vegetables, fruit, milk; 3) Provide religious spiritual support, for example sending or guiding to recite prayers for healing; and 4) Provide non-spiritual support, for example sending songs/videos to entertain, invite to chat, show concern, ask news, and so on. The result showed that "one-house family" is the most influential factor for non-medical healing of Covid-19 patients in east-Java, Indonesia. The results of this study have produced a method using a new IFS similarity measure that can be implemented in other appropriate cases.

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