A Hybrid Computation_JATIT.pdf

by Edy Winarno

Journal of Theoretical and Applied Information Technology
30th November 2019. Vol.97. No 22

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

A HYBRID COMPUTATIONAL METHOD OF TRIANGULAR FUZZY NUMBER ARITHMETIC APPROACH AND TOPSIS FOR FOOD CROPS SELECTION ON DRY LAND

[1]WIWIEN HADIKURNIAWATI, [2]EDY WINARNO, [3]DWI BUDI SANTOSO, [4]PURWATININGTYAS

[1,2,3,4]Faculty of Information Technology, Universtas Stikubank, Indonesia

E-mail: [1]wiwien@edu.unisbank.ac.id, [2]edywin@edu.unisbank.ac.id [3]dbs@edu.unisbank.ac.id, [4]purwati@edu.unisbank.ac.id

ABSTRACT

Humans often have difficulty making decisions in complex, subjective situations with many realistic choices.So it takes a systematic and organized mathematical way to evaluate choices and find the best solution to the problem. This study uses the hybrid computational method of fuzzy triangular number (TFN) and TOPSIS approaches to solve the problem. Linguistic values which are triangular fuzzy numbers are used to determine decision-makers' preferences. Implementation of the hybrid triangular fuzzy number arithmetic approach and TOPSIS method in real-life problems helps the farmer to take a correct decision of food crops from the available alternatives. The application of the proposed model can help the user in determining the most suitable food crops to be planted in certain fields with eleven land characteristics parameters.

Keywords: *Multi Attribute Decision Making, Arithmetic Approach, Triangular Fuzzy Number, Food Crops*

1. INTRODUCTION

Problems in the real world are increasingly complicated, resulting in several computational models being combined so that they can produce wise decisions. Uncertain problems require solutions that have high technical capability computational models. Decision making can be explained as the process of choosing the right alternative from several alternatives based on available preferences [1][2]. This is an important step in many applications such as organizational management, risk assessment, product evaluation, and recommendations [3][4][5]. The right decision is influenced by many factors. A good decision-making system is needed and under the procedures for scientific decision making. Multi-attribute decision making (MADM) is the most famous decision-making branch. This is a general class of operations research models related to decision problems that are influenced by several decision parameter [6].

Solving problems in MADM includes alternative ranking. In determining the final rank of many alternatives, the MADM approach combines preference information from decision-makers in a decision matrix. The best ranking alternative must be the optimal decision. In some traditional attribute decision making (MADM) problems, the values calculated from each alternative are crisp numbers [7][8]. [9] in their study proposed a model for extracting visual content and topics from images using the MADM approach to the Technique for Preference Sequence method with the Similarity to Ideal Solution (TOPSIS) model.

[10] proposes the design of uncertainty assessment on decision-making using the approach of Analytical Hierarchy Process (AHP). This process can solve the problem of group decision making based on consensus. Consensus decision-making can choose one of the two choices available. [11] in his study discussed multi-criteria decision making that can provide advice for students to choose study programs at universities based on students' academic abilities.

In real decision-making problems, decision-makers use the term natural linguistic language to express their preferences qualitatively for choices available. An important part of making decisions about any problem is the uncertainty of

Journal of Theoretical and Applied Information Technology
30th November 2019. Vol.97. No 22

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

the data due to a lack of clear information about the problem. Qualitative information is often used in decision making. Linguistic term and not a numerical term whose value is imprecise. The value used is always vague and imprecise [12][13].

There have been many studies that analyze methods for evaluating performance from several alternatives given. In previous studies, it was found that there are several fuzzy methods to evaluate performance. Fuzzy values expressed by the degree of membership reflect human intuitionbecause this helps experts who provide uncertain or ambiguous preferences in evaluating alternatives. The combination of MADM and fuzzy set theory results in a new decision-making theory called Fuzzy MADM [14]. Human judgment or preference can be represented by fuzzy values. This motivates decision-makers to use these values in solving decision-making problems. Fuzzy numbers are mathematical concepts in fuzzy set theory used to represent subjectivity in human judgment. This human judgment is expressed in linguistics.In fuzzy MADM problems, alternative evaluations are expressed in fuzzy Decision Matrix. This matrix consists of the degree of membership of each alternative for each attribute[15]. Under the fuzzy environment, fuzzy multi-attribute decision making (FMADM) requires linguistic values to express inaccuracies (e.g. very good, good, bad, moderate). This linguistic value allows decision-makers to express opinions more fairly. The linguistic value requires a device to calculate or evaluate one preference. Researchers in [16] have succeeded in using fuzzy numbers to represent linguistic variables to evaluate the performance of urban public transportation systems. Fuzzy numbers are used, among others, to also evaluate the performance of engineering consultants [17] and performance evaluation of manufacturing plants in Wujiang [18]. [13] on their group decision-making research used fuzzy approach to determine the highest priority of alternative. Linguistic variables are used to represent a subjective assessment of the decision-makers so that the uncertainty and imprecision in the selection process can be minimized. In this paper, triangular fuzzy numbers (TFN) are operated with a fuzzy arithmetic approach combined with the TOPSIS method to obtain an alternative rating.

Indonesia is an agricultural country. The majority of Indonesians work in agriculture. This is contrary to reality because the area of land used for agriculture has been depreciated for a longer time. This problem causes a decrease in the quality and quantity of agricultural land resources. Each land has conditions that are sometimes not suitable for certain types of food crops. A model is needed that can analyze the conditions and suitability of dry land with suitable crops for cultivation.It also can give the recommended crops to farmers, to maximize the agricultural products.The model developed in Multi-Attribute Decision Making (MADM) using a triangular fuzzy arithmetic approach and the TOPSIS method that is implemented in determining the type of food crops on dry land, based on land parameters and compatibility with the characteristics of food crops.

2. HYBRID METHOD OF DECISION MAKING

To implement a model that represents expert knowledge of the criteria in an inaccurate situation, a weighting method is used. If method A depends on method B, then y is associated with adding a directed connection from B to A. The weight equation between methods affects the final result. The MADM method can be combined with other methods to calculate the relative significance of the parameters. The reason why using a hybrid method of decision making are :

1. Model decision making, solutions must approach real problems. There are many difficulties and ambiguities. Inaccuracy in the decision-making process usually starts from an uncertain managerial context, there is ambiguity that makes it difficult to reach the right decision.Fuzzy logic can solve uncertainty problems that usually come from human judgment. [19]
2. The rank of alternative and recommendation of decision depending on the importance of each criterion. This problem can be solved by the weighting of criteria. The hybrid model approach can complete two tasks simultaneously. The two tasks are to determine the weight of the parameters and combine them to the value of the multi-attribute utility function. [5]
3. The use of different MADM methods sometimes results in different alternative ratings. Therefore, it is recommended to use more than one MADM method and to integrate the results of final decision making. [6]

Many researchers have researched in the field of decision making using hybrid methods. [12], [13], [14], [15] conducted a study using fuzzy AHP-TOPSIS framework to solve problems at decision making. AHP method is used to determine the weight of the parameter and TOPSIS method is

Journal of Theoretical and Applied Information Technology
30th November 2019. Vol.97. No 22

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

applied to prioritize alternatives. [7] proposed a decision-making model that use three methods of MADM to determine the highest priority of alternatives. The weight of parameters is determined using the Analytic Hierarchy Process (AHP) method. To normalize the test data using the Simple Additive Weighting (SAW) method and TOPSIS is used to rank the alternative.

Subjectivity, uncertainty, and obscurity in the decision-making process are solved using linguistic variables. This variable is a parameter stated by triangular fuzzy numbers (TFN). This can reduce differences in perceptions and qualitative influential factors in the subjective environment. Fuzzy set theory and linguistic variables using TFN are used to determine the weight of parameter importance. [20] used linguistic values expressed by triangular fuzzy number for their decision-making framework.The output is the best alternative obtained using TFN arithmetic approach [21].

Triangular fuzzy number (TFN) in decision-making applications is used to evaluate available alternatives. The final score would determinethe most qualified candidate. Another popular method is FTOPSIS used to improve the gaps between the alternative performance and the actual results and also finding the best alternative who is desired for the post based on the important criteria [22][23].

Many problems in the real world with unclear situations. To solve this problem, the right decision-making method is needed. Fuzzy multi attribute decision making (FMADM) is the right method to solve it because it can describe in the form of linguistic values in situations that are rationally uncertain. This was also proposed by Bekheet [24] with Polygon Fuzzy Number (PFN) as a decision-making method for expressing linguistics. The FMADM method presents a comprehensive evaluation of satisfaction. This can solve the problem of fuzzy situations when making decisions where decision data and weight of all attributes are in the form of general fuzzy trapezoid numbers (GTFN) [25]

This study proposes a multi-attribute decision-making model based on the hybrid method of triangular fuzzy number arithmetic approach and TOPSIS method for food crops selection on dry land. The proposed model can be seen in Figure 1. This paper is structured as follows. Section 1 describes the background the problem and the works related to our research. Section describes the approach of decision making hybrid methods, Section 3 discusses the case study and the results of our research. Our conclusions are presented in Section 4.

2.1. Triangular Fuzzy Number Arithmetic Approach

Fuzzy numbers are real numbers that refer to many numbers of possible values, where each value weights between 0 and 1. The weight between 0 and 1 is called the degree of membership. Let X be a universal set. The fuzzy subset A of X is defined by its membership degree.

$$\mu_A : X = [0, 1] \quad (1)$$

Which states the real number μA (x) in the interval of the fuzzy value [0,1] for each element x ϵ X. The value of μA (x) at x indicates the level of membership x in the set A.

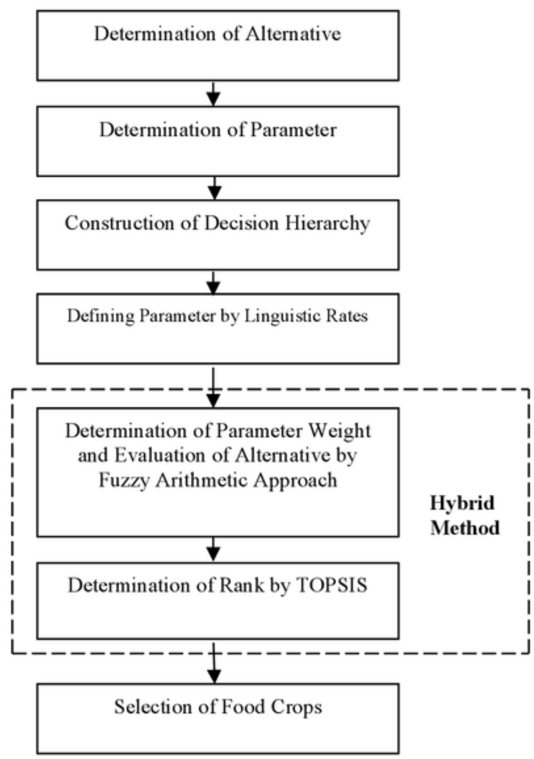

Figure 1: The Proposed Model

Triangular fuzzy numbers are expressed as three values as follows: A = (a1, a2, a3). This is interpreted as the degree of membership of fuzzy numbers which state :

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

(i) a1 and a2 are rising functions
(ii) a2and to a3 are decreasing functions
(iii) $a_1 \leq a_2 \leq a_3$

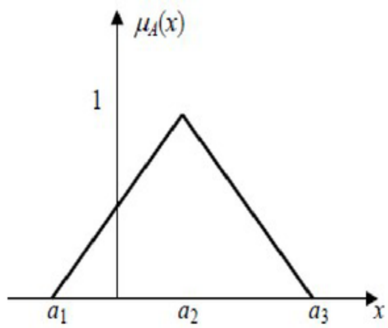

Figure 2. Triangular Fuzzy Number

This representation is expressed as a membership function as shown in figure 1.

$$\mu_{(A)}(x) = \begin{cases} 0, & x < a_1 \\ \frac{x-a_1}{a_2-a_1}, & a_1 \leq x \leq a_2 \\ \frac{a_3-x}{a_3-a_2}, & a_2 \leq x \leq a_3 \\ 0, & x > a_3 \end{cases} \quad (2)$$

Basic arithmetic operations on fuzzy numbers is an expanded concept of basic arithmetic operations using fuzzy sets that include fuzzy membership degrees. Some important properties of operations on triangular fuzzy numbers are:

1. The result of adding or subtracting between triangular fuzzy numbers is also a triangular fuzzy number.
2. The results of the multiplication or division are not in the form of a triangular fuzzy number. The results of multiplication and division operations can be used as triangular fuzzy numbers with approach values.

Triangular fuzzy numbers are not generated from min or max operations.

2.2. Triangular Fuzzy Number Operation

Here, the presented fuzzy arithmetic is approached with arithmetic intervals. The algorithm of the method developed is given in a numerical example. This method uses four bases arithmetic operations applied to two TFNs. The procedure for solving fuzzy equations is to represent fuzzy numbers in the form of α-cut using the triangular membership function. Then operate it using basic arithmetic operations on fuzzy numbers. Determination of the results of arithmetic operations in fuzzy equations is to represent the fuzzy numbers with α-cut so that new fuzzy numbers are obtained as a result of solving the fuzzy equation. Arithmetic operations can use the α-cut method. The arithmetic operations are addition, subtraction, multiplication, and division. It is a method which is general enough to deal with all kinds of fuzzy arithmetic including nth root, exponentiation and taking log.The α-cut set α-level set fuzzy A is a set consisting of elements in the universe of set X. This set has a membership value of more than the α threshold. In this section arithmetic operations with fuzzy numbers are used using the α-cut method to evaluate problems.

1. Addition of Fuzzy Numbers

Let $A = [a_1, a_2, a_3]$ and $B = [b_1, b_2, b_3]$ be two fuzzy numbers. Then $A_\alpha = [(a_2 - a_1)\alpha + a_1, a_3 - (a_3 - a_2)\alpha]$ and $B_\alpha = [(b_2 - b_1)\alpha + b_1, b_3 - (b_3 - b_2)\alpha]$ are the α-cuts of fuzzy numbers A and B. To calculate addition of fuzzy numbers A and B we first add the α-cuts of A and B using interval arithmetic.

$$A_\alpha + B_\alpha = [(a_2 - a_1)\alpha + a_1, a_3 - (a_3 - a_2)\alpha] + [(b_2 - b_1)\alpha + b_1, b_3 - (b_3 - b_2)\alpha]$$
$$= [a_1 + b_1 + (a_2 - a_1 + b_2 - b_1)\alpha, a_3 + b_3 - (a_3 - a_2 + b_3 - b_2)\alpha] \quad (3)$$

3. Substraction of Fuzzy Numbers

Let $A = [a_1, a_2, a_3]$ and $B = [b_1, b_2, b_3]$ be two fuzzy numbers. Then $A_\alpha = [(a_2 - a_1)\alpha + a_1, a_3 - (a_3 - a_2)\alpha]$ and $B_\alpha = [(b_2 - b_1)\alpha + b_1, b_3 - (b_3 - b_2)\alpha]$ are the α-cuts of fuzzy numbers A and B. To calculate substraction of fuzzy numbers A and B we first substract the α-cuts of A and B using interval arithmetic.

$$A_\alpha - B_\alpha = [(a_2 - a_1)\alpha + a_1, a_3 - (a_3 - a_2)\alpha] - [(b_2 - b_1)\alpha + b_1, b_3 - (b_3 - b_2)\alpha]$$
$$= [(a_2 - a_1)\alpha + a_1 - (b_3 - (b_3 - b_2)\alpha), a_3 - (a_3 - a_2)\alpha - ((b_2 - b_1)\alpha + b_1)]$$
$$= [(a_1 - b_3) + (a_2 - a_1 + b_3 - b_2)\alpha, (a_3 - b_1) - (a_3 - a_2 + b_2 - b_1)\alpha] \quad (4)$$

4. Approach to Multiplication

The main concern is the cut of two fuzzy numbers.

$A = (a_1, a_2, a_3)$, $B = (b_1, b_2, b_3)$

$A_\alpha = [(a_2 - a_1)\alpha + a_1, -(a_3 - a_2)\alpha + a_3]$

$B_\alpha = [(b_2 - b_1)\alpha + b_1, -(b_3 - b_2)\alpha + b_3]$

For all a ϵ [0,1], multiply A_α with B_α which is the interval of real numbers.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

$A\alpha$ (·) $B\alpha$ = [(a_2 – a_1)α + a_1, - (a_3 – a_2)α + a_3] (·)[(b_2 – b_1)α + b_1, - (b_3 – b_2)α + b_3] (5)

Approach results $A\alpha$ (·) $B\alpha$ determined by value α = 0 dan α = 1.

5. Approach to Division

In the same way as multiplication, the value approach (A / B) can be expressed as a triangular fuzzy number.

$A\alpha$ (/) $B\alpha$ = [(a_2 – a_1)α + a_1 / - (b_3 – b_2)α + b_3, - (b_3 – b_2)α + b_3 / (b_2 – b_1)α + b_1] (6)

2.3. Fuzzy TOPSIS (Technique For Order of Preference By Similarity To Ideal Solution)

The fuzzy TOPSIS (Order Preference Technique by Similarity to an Ideal Situation) can be used to evaluate several alternatives to the selected criteria. In the TOPSIS approach, the closest alternative to the Ideal Positive Fuzzy Solution (FPIS) and the furthest from the Negative Fuzzy Solution (FNIS) is chosen as the optimal alternative. An FPIS consists of the best performance values while FNIS consists of the shortest performance values for each alternative. Fuzzy TOPSIS approach is used to rank alternatives based on aggregate decision matrix, individual decision matrix, and weight vector.

Steps of fuzzy TOPSIS procedure :

Create a weighted and normalized decision matrix.

a. Determine the fuzzy positive-ideal solution (FPIS) and fuzzy negative-ideal solution (FNIS)
b. Calculate the distances of each alternative from the FPIS (A*) and the FNIS (A-).
c. The Euclidean distances between each of the alternatives, the fuzzy positive ideal and fuzzy negative ideal solutions (closeness coefficient). Calculate the closeness coefficient of each alternative as in equation (7).

$$d_i^* = \sqrt{\sum_{j=1}^{n} d\,(v_{ij}^{\sim}\,, v_{ij}^{\sim *})^2}\ , i = 1,2,\ldots,m$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} d\,(v_{ij}^{\sim}\,, v_{ij}^{\sim -})^2}, i = 1,2,\ldots,m. \qquad (7)$$

Where d (d_i^*,d_i^-) is the distance measurement between two fuzzy numbers.

d. The next step is to determine the proximity coefficient. This coefficient is used to determine the rank order of alternatives according to the equation (8).

$$CC_i = \frac{d_i}{d_i^* + d_i^-} \qquad (8)$$

e. Determine the rank order of all alternatives based on proximity coefficients. The proximity coefficient of each alternative is used to determine the ranking order of all alternatives. If an alternative is closer to the FPIS value and farther than the FNIS value, the proximity coefficient value is high.

3. CASE STUDY

In farming, land quality will determine the quality and quantity of food crop productivity. Most farmers determine the type of food crops manually on certain lands. Field data compared with parameters needed in using land for certain crops. This resulted in information that was expensive and drained the time and effort.

Soil quality that depends on the soil characteristics of a land, will determine the results of crop production. Slopes, soil texture, rainfall, water discharge, effective depth and so on are the parameters that make up the characteristics of a land. Food growth will depend on these main parameters, so it is important to pay attention when choosing food plants on dry land.

Land suitability aims for a field of land suitable for certain uses. Land suitability classes vary. This depends on the land use itself. Not every land has the right conditions for planting certain types of food crops. The characteristics of dry land in general are: 1). Low soil fertility, 2). Source of irrigation from rainwater, 3). Typical topography is not flat land, 4). The shallow layer of soil, 5). Susceptible to degradation and erosion, 6). Low levels of soil organic matter.

This decision-making model uses 11 parameters, including physical and chemical parameters, as well as natural factors such as temperature and rainfall, in determining land suitability. The objects used in this study include 5 types of food crops. Alternative food crops, namely: corn, soybeans, green beans, sweet potatoes, and upland rice will be matched with eleven soil parameters, namely: rainfall (mm / year), temperature (◦C), slope class (%), drainage, erosion, texture, effective depth (cm), pH, cation exchange capacity (me / 100gram), alkaline saturation (%), C-organic (%). They will be matched with the dry soil conditions in Kendal district.

By matching land suitability based on these criteria, it will be easier for farmers to determine which food crops are suitable for the area. Agricultural products are expected to increase. The long-term goal to be achieved is to increase land productivity, reduce the risk of failure, protect

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

natural resources and prevent land and water degradation, increase farmers' income.

Linguistic variables represent the weights for each parameter can be seen on Table 1

Table 1: Parameter Weights

Parameters	Weights
Rainfall (P1)	(0.8, 0.9, 1)
Temperature (P2)	(0.9, 1, 1)
Grade Slope (P3)	(0.7, 0.8, 0.9)
Drainage (P4)	(0.4, 0.5, 0.6)
Erosion (P5)	(0.5, 0.6, 0.7)
Texture (P6)	(0.6, 0.7, 0.8))
Effective Depth (P7)	(0.3, 0.4, 0.5)
pH (P8)	(0.1, 0.2, 0.3)
Cation Exchange Capacity (P9)	(0, 0, 0.1)
Saturation Bases (P10)	(0, 0.1, 0.2)
C-Organic (P11)	(0.2, 0.3, 0.4)

The processes at this stage are:
The degree of suitability of alternatives with decision parameters is:

$$T_{(importance)}\ W = \{VP, P, M, G, VG\}$$

Each represented by triangular fuzzy numbers as follows :

- VP (Very Poor) = (0, 0, 0.25)
- P (Poor) = (0, 0.25, 0.5)
- M (Medium) = (0.25, 0.5, 0.75)
- G (Good) = (0.5, 0.75, 1)
- VG (Very Good) = (0.75, 1, 1)

Determine the value of matching fuzzy numbers by adding the weight of the degree of alternative importance on each parameter, by multiplying the alternative degree match rating on each parameter using equation 2.

Alternative A1 (Maize)

a. The suitability rating for Alternative A1 (Maize) for parameter 1 is Good (G) = (0.5, 0.75, 1) and the rating of importance for parameter 1 is (0.8, 0.9, 1)

Fuzzy match values are determined using the multiplication value approach in fuzzy, as follows:

$$A = (0.5, 0.75, 1)$$
$$B = (0.8, 0.9, 1)$$

$$A_\alpha = [(0.75–0.5)\alpha+0.5, – (1-0.75)\alpha+1]$$
$$= [0.25\alpha+0.5, - 0.25\alpha+1]$$
$$B_\alpha = [(0.9-0.8)\alpha+0.8, - (1-0.9)\alpha+1]$$
$$= [0.1\alpha+0.8, - 0.1\alpha+1]$$

$$A_\alpha (\cdot) B_\alpha = [0.25\alpha+0.5, - 0.25\alpha+1] (\cdot) [0.1\alpha+0.8, - 0.1\alpha+1]$$
$$= [(0.25\alpha+0.5) (0.1\alpha+0.8), (-0.25\alpha+1) (-0.1\alpha+1)]$$
$$= [0.025\alpha^2+0.25\alpha+0.4, 0.025\alpha^2-0.35\alpha+1]$$
$$A_\alpha (\cdot) B_\alpha \cong (0.4, 0.675, 1)$$

Journal of Theoretical and Applied Information Technology
30th November 2019. Vol.97. No 22

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

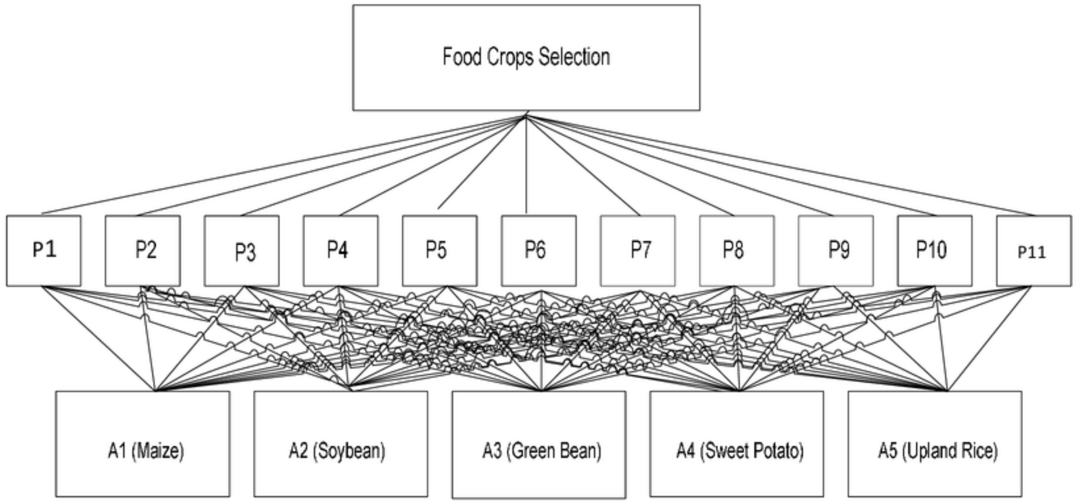

Figure 3: Construction O f Decision Hierarchy

Table 2: The Linguistic Variables of Each Alternative Toward Parameters

PARAMETERS	ALTERNATIVES				
	MAIZE (A1)	SOYBEAN (A2)	GREEN BEAN (A3)	SWEET POTATO (A4)	UPLAND RICE (A5)
Rainfall (P1)	G	M	VG	P	P
Temperature (P2)	VP	VP	P	VP	P
Grade Slope (P3)	VG	VG	VG	G	P
Drainage (P4)	G	G	G	G	G
Erosion (P5)	VG	VG	VG	VG	VG
Texture (P6)	VG	G	VG	M	G
Effective Depth (P7)	P	P	P	P	VG
pH (P8)	M	P	M	M	VG
Cation Exchange Capacity (P9)	G	G	G	G	G
Saturation Bases (P10)	M	M	M	M	M
C-Organic (P11)	M	M	M	M	G

b. The suitability rating for Alternative A1 (Maize) for parameter 2 is Very Poor (VP) = (0, 0, 0.25) and the rating of importance for parameter 2 is (0,9, 1, 1).

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Fuzzy match values are determined using the multiplication value approach in fuzzy, as follows:

A = (0, 0, 0.25)

B = (0.9, 1, 1)

$A\alpha = [(0-0)\alpha+0, -(0.25-0)\alpha+0.25]$

$= [0, -0.25\alpha+0.25]$

$B\alpha = [(1-0.9)\alpha+0.9, -(1-1)\alpha+1]$

$= [0.1\alpha+0.9, 1]$

$A\alpha (\cdot) B\alpha = [0, -0.25\alpha+0.25] (\cdot) [0.1\alpha+0.9, 1]$

$= [(0)(0.1\alpha+0.9), (-0.25\alpha+0.25)(1)]$

$= [0, -0.25\alpha^2+0.25]$

$A\alpha (\cdot) B\alpha \cong (0, 0, 0{,}25)$

Table 3: The Aggregated Weighted and Normalized Matrix Fuzzy Decision Matrix of Alternatives

PARAMETERS	ALTERNATIVES				
	A1	A2	A3	A4	A5
P1	(0.4, 0.75, 1)	(0.2, 0.45,0.75)	(0.6, 0.9, 1)	(0, 0.225, 0.5)	(0, 0.225, 0.5)
P2	(0, 0, 0.25)	(0, 0, 0.25)	(0, 0.25, 0.5)	(0, 0, 0.25)	(0, 0.25, 0.5)
P3	(0.525, 0.8,0.9)	(0.525, 0.8,0.9)	(0.525, 0.8,0.9)	(0.35, 0.6, 0.9)	(0, 0.2, 0.45)
P4	(0.2, 0.375,0.6)	(0.2, 0.375,0.6)	(0.2, 0.375,0.6)	(0.2, 0.375,0.6)	(0.2, 0.375,0.6)
P5	(0.375, 0.6,0.7)	(0.375, 0.6,0.7)	(0.375, 0.6,0.7)	(0.375, 0.6,0.7)	(0.375, 0.6,0.7)
P6	(0.45, 0.7, 0.8)	(0.3, 0.525,0.8)	(0.45, 0.7, 0.8)	(0.15, 0.35,0.6)	(0.3, 0.525,0.8)
P7	(0, 0.1, 0.25)	(0, 0.1, 0.25)	(0, 0.1, 0.25)	(0, 0.1, 0.25)	((0.225, 0.4, 0.5)
P8	(0.025, 0.1, 0.225)	(0, 0.05, 0.15)	(0.025, 0.1, 0.225)	(0.025, 0.1, 0.225)	(0.075, 0.2, 0.3)
P9	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)	(0, 0, 0)
P10	(0, 0.15, 0.5)	(0, 0.15, 0.5)	(0, 0.15, 0.5)	(0, 0.15, 0.5)	(0, 0.15, 0.5)
P11	(0.05, 0.15, 0.3)	(0.05, 0.15, 0.3)	(0.05, 0.15, 0.3)	(0.05, 0.15, 0.3)	(0.1, 0.225, 0.4)

c. The suitability rating for Alternative A1 (Maize) for parameter 3 is Very Good (VG) = (0.75, 1, 1) and the rating of importance for parameter 3 is (0.7, 0.8, 0.9).
Fuzzy match values are determined using the multiplication value approach in fuzzy, as follows:

A = (0.75, 1, 1) B = (0.7, 0.8, 0.9)

$A\alpha = [(1-0.75)\alpha+0.75, -(1-1)\alpha+1]$

$= [0.25\alpha+0.75, 1]$

$B\alpha = [(0.8-0.7)\alpha+0.7, -(0.9-0.8)\alpha+0.9]$

$= [0.1\alpha+0.7, -0.1\alpha+0.9]$

$A\alpha (\cdot) B\alpha = [0.25\alpha+0.75, 1] (\cdot) [0.1\alpha+0.7, -0.1\alpha+0.9]$

$= [(0.25\alpha+0.75)(0.1\alpha+0.7), (1)(-0.1\alpha+0.9)]$

$= [0.025\alpha^2+0.25\alpha+0.525, -0.1\alpha+0.9]$

$A\alpha (\cdot) B\alpha \cong (0.525, 0{,}8, 0{,}9)$

In the same way Triangular Fuzzy Number (TFN) can be determined from alternative weighting with parameters for all parameters (P1-P11) and other alternatives, namely Alternative A2 (Soybean), Alternative 3 (Green Bean), Alternative 4 (Sweet Potato) and Alternative 5 (Upland Rice). The results of determining the value of fuzzy matches for each alternative to all complete parameters as in the table 3.

Table 4: The Distance between Each Parameter

Parameters	Alternatives									
	A1		A2		A3		A4		A5	
	v^+	v^-	v^+	v^-	v^+	v^-	v^+	v^-	v^+	v^-
P1	0.375278	0.757738	0.578792	0.518009	0.238048	0.85049	0,785414	0,316557	0,785414	0,316557
P2	0.433013	0.144338	0.433013	0.144338	0.433013	0.322749	0,433013	0,144338	0,322749	0,322749
P2	0.224072	0.758425	0.224072	0.758425	0.224072	0.758425	0,361709	0,656379	0,707696	0,284312
P3	0.264969	0.252075	0.264969	0.252075	0.264969	0.252075	0,264969	0,252075	0,264969	0,252075
P4	0.19632	0.228218	0.19632	0.228218	0.240442	0.228218	0,19632	0,228218	0,19632	0,228218
P5	0.210159	0.521217	0.329457	0.441824	0.210159	0.521217	0,470815	0,284312	0,329457	0,441824
P6	0.396863	0.155456	0.396863	0.155456	0.396863	0.155456	0,396863	0,155456	0,168943	0,479909
P7	0.201039	0.142887	0.241523	0.091287	0.201039	0.142887	0,201039	0,142887	0,142156	0,212623
P8	0	0	0	0	0	0	0	0	0	0
P9	0.352373	0.301386	0.352373	0.301386	0.352373	0.301386	0,352373	0,32914	0,352373	0,301386
P10	0.254951	0.155456	0.254951	0.155456	0.254951	0.155456	0,254951	0,155456	0,20052	0,227761
P11	0.375278	0.757738	0.578792	0.518009	0,238048	0,85049	0,785414	0,316557	0,785414	0,316557

In the TOPSIS method, the distance between the values of each alternative with a matrix of ideal positive solutions (Di +) and a negative solution matrix (Di +) must be calculated to determine the best distance. The distance is calculated using equation 7. From the calculation of the weight values of each alternative to D1 + and D1- using equation {7}, the complete results can be seen in table 8

For each alternative, determine the value of its preference (Vi). This preference value can be calculated using equation 8. The alternative with the highest Vi value from the ideal solution will rank the best priority.Based on the distance shown in table 5, the distance obtained using equation (8) in green beans (A3) is the plant with the largest calculation value, then sequentially maize, upland rice, soybean and cassava is the last rank. Thus green beans are the highest alternative recommended as a decision for plants grown on dry land with characteristics grouped in these 11 parameters

4. COMPREHENSIVE ANALYSIS

Many parameters are needed in food crops selection. The arithmetic approach of fuzzy triangle numbers is used in this research as a tool in decision making for selected food crops. In reality uncertainties and inaccuracies in the selection process often occur. This is why linguistic values are needed for fuzzy numbers. The results of the selection in the form of an aggregation on the fuzzy triangle numbers will be displayed in the form of a final rating of each food crop.

The comparison method for this case relies on the two-step AHP and TOPSIS to select the best food plants. AHP is used to calculate the weight of an attributes or criteria and the overall weight of a candidate in each parameter. The TOPSIS method is used to increase the gap between alternative performance and actual results and also find the best alternative. For the same case with eleven parameters and five alternative food crops using the AHP-TOPSIS hybrid method, the following decision-making recommendations are determined.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

From table 6, the recommendations offered by the two decision making methods (hybrid TFN arithmetic approach-TOPSIS and hybrid AHP-TOPSIS) are the same. Alternative A3 (Green Beans) is the highest order alternative. This shows that the proposed method is valid because the alternative priority results are the same when calculated with other methods.

Table 5: Rank of Alternatives

	Alternatives				
	A1	**A2**	**A3**	**A4**	**A5**
di-	3.417194539	3.046473224	3.688357778	2.664817844	3.067411861
di*+	2.909035625	3.272331726	2.815927549	3.717464826	3.470595673
CCi	0.540162854	0.482128068	0.567065802	0.41753366	0.469166156
Rank	**2**	**3**	**1**	**5**	**4**

Table 6: Comparison Alternatives Rank with Other Method

Alternatives	Hybrid TFN Arithmetic Approach-TOPSIS		Hybrid AHP-TOPSIS	
	Value	**Rank**	**Value**	**Rank**
A1 (Mayze)	0.5402	2	0.6474	2
A2 (Soybean)	0.4821	3	0.4820	3
A3 (Green Beans)	0.5671	1	0.7808	1
A4 (Sweet Potato)	0.4175	5	0.2191	5
A5 (Upland Rice)	0.4692	4	0.4690	4

5. CONCLUSION

This study uses the hybrid method of fuzzy triangular number (TFN) and TOPSIS approaches to solve the problem of determining food crops on certain land. Decision maker preferences are represented by lingusitic values which are triangular fuzzy numbers. That can minimize uncertainty and imprecision in the selection proces.

The proposed model, namely hybrid triangular fuzzy number arithmetic approach and TOPSIS method can be a model management in multi attribute decision making. Implementation of the model can be developed as an application that can recommend food crops to be planted by farmers. The application of the proposed model can help users in determining the most suitable food crops to be planted on certain land according to the characteristics of the land.

Based on the results of calculations using the hybrid triangular fuzzy number arithmetic approach and TOPSIS method, it was found that green bean crops were the highest priority for planting on dry land based on eleven characteristic groups as parameters

REFERENCES

[1] M. Parimala and D. Lopez, "Decision Making in Agriculture Based on Land Suitability-Saptial Data Analysis Approach", *Journal of Theoretical and Applied Information Technology {JATIT}*, Vol.46, No.1, 2012, pp. 17-23.

[2] D.R. Anamisa, A. Rachmad, R. Widiastutik, "Selection System of The Boarding House Based on Fuzzy Multi Attribute Decision Making Method", *Journal of Theoretical and*

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Applied Information Technology {JATIT}, Vol. 92, No. 1, 2016, pp. 52-28.

[3] M. Raikhan, K. Bolat, Z. Meiram, O. Altynay, "Assessing Information Security Risk With The Fuzzy Set Theory", *Journal of Theoretical and Applied Information Technology {JATIT}*, Vol. 96, No. 11, 2018, pp. 3142-3152.

[4] B.J. Jaya and J.J. Tamilselvi, "Fuzzy Multi-Criteria Random Seed and Cutoff Point Approach for Credit Risk Assessment", *Journal of Theoretical and Applied Information Technology {JATIT}*, Vol. 96, No. 4, 2018, pp. 1150-1163.

[5] V. Ibanez-Fores, M.D. Bovea, V. Perez-Belis, "A Holistic Review of Applied Methodologies for Assessing and Selecting The Optimal Technological Alternative from A Sustainability Perspective", *Journal of Cleaner Production*, Vol. 97, No. 2, 2019, pp. 476-489.

[6] E.K.Zavadskas, K.Govindan, J.Antucheviciene, Z. Turskis, "A Hybrid Multiple Criteria Decision-Making Methods : A Review of Applications for Sustainability Issues", *Economic Research-Ekonomiska Istrazivanja*, Routledge Tailor & Francis Group, Vol. 29, No. 1, 2016, pp. 857-887.

[7] W. Hadikurniawati and R. Wardoyo,, "A Hybrid Multi-Attribute Decision Making for Electrician Selection Based on AHP, SAW and TOPSIS", *Journal of Theoretical and Applied Information Technology {JATIT}*, Vol. 77, No. 1, 2015, pp. 136-142.

[8] Hamdani and R. Wardoyo, "A Review on Fuzzy Multi-Criteria Decision Making Land Clearing for Oil Palm Plantation", *International Journal of Advances in Intelligent Informatics (IJAIN)*, Vol. 1, No. 2, 2015, pp. 75-83.

[9] H. Deljooi and A. R. Eskandari, "A Novel Semantic Statistical Model for Automatic Image Annotation Using the Relationship between the Regions Based on Multi Criteria Decision Making", *International Journal of Electrical and Computer Engineering (IJECE)*, Vol. 4, No. 1, 2014, pp. 37-51.

[10] C.J. Hopfe, G.L.M. Augenbroe, J.L.M Hensen, "Multi-Criteria Decision Making Uncertainty in Building Performance Assesment", *Building and Environment*, Elsevier, Vol. 69, 2013, pp. 81-90.

[11] M. Sudarma, A.A.K.O. Sudana, I. Cahya, "Decision Support System for the Selection of Courses in the Higher Education using theMethod of Elimination Et Choix Tranduit La Realite", *International Journal of Electrical and Computer Engineering (IJECE)*, Vol. 5, No. 1, 2015, pp. 129-135.

[12] J. Ouahli and A. Cherkaoui, "Team Performance in Safety Critical Systems : Review and Approximation by Fuzzy-AHP", *Journal of Theoretical and Applied Information Technology {JATIT}*, Vol. 97, No. 13, 2019, pp. 3767-3782.

[13] W. Hadikurniawati and K.. Mustofa, "Multicriteria Group Decision Making Using Fuzzy Approach for Evaluating Criteria of Electrician", *International Journal of Electrical and Computer Engineering (IJECE)*, Vol. 6, No. 5, 2016, pp. 2462-2469.

[14] I. Igoulalene, L. Benyoucef, M.K. Tiwari, "Novel fuzzy hybrid multi-criteria group decision making approaches for the strategic supplier selection problem", *Expert System with Application, Elsevier*, Vol. 42, 2015, pp. 3342-3356.

[15] W. Hadikurniawati and R. Wardoyo, "A Multi-Attribute Decision Making for Electrician Selection using Triangular Fuzzy Numbers Arithmetic Approach", *International Journal of Advanced Computer Science and Application*, Vol. 6, No. 9, 2015, pp. 173-178.

[16] M. Stankovic, P. Gladovic, V. Popovic, V. Lukovac, "Selection Criteria and Assessment of the Impact of Traffic Accessibility on the Development of Suburbs", *Sustainability,* Vol. 10, No. 1977, 2018.

[17] D. Deliktas and O.Ustun, "Multiple Criteria Decision Making Approach For Industrial Engineer Selection Using Fuzzy AHP-Fuzzy TOPSIS", *Anadolu University Journal if Sciece and Technology A-Applied Science and Engineering,* Vol. 19, No. 1, 2018, pp.58-82.

[18] V.F. Yu and K.J.Hu, "An Integrated Fuzzy Multi-Criteria Approach For The Performance Evaluation of Multiple Manufacturing Plants", *Computer & Industral Engineering*, Vol.58, No. 2, 2010, pp. 269-277.

[19] K. Govindan, D. Kannan, M Shankar, "Evaluation of Green Manufacturing Practices using A hybrid MCDM Model Combining DANP with PROMETHEE", *International Journal of Production Research*, Vol 53, No. 21, 2015.

[20] Md. Yasin Ali, A. Sultana, A.F.M. Khodadad Khan, "Comparison of Fuzzy Multiplication Operation on Triangular Fuzzy Number", *IOSR Journal of Mathemetic (IOSR-JM)*, Vol. 12, No. 42, 2016, pp. 35-41.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[21] A. Bandono, O.S. Suharyo, Riono, "Applied Fuzzy and Nasa TLX Method to Measure of The Mental Workload", *Journal of Theoretical and Applied Information Technology {JATIT}*, Vol. 97, No. 2, 2019, pp. 476-489.

[22] F.R.L. Junior, L. Osiro, L.C.R. Carpinetti, "A Comparison Between Fuzzy AHP and Fuzzy TOPSIS Methods to Supplier Selection", *Applied Soft Computing, Elsevier*, Vol. 21, 2014, pp. 194-209.

[23] C. Prakash and M.K. Barua, "Integration of AHP-TOPSIS method for prioritizing the solutions of reverse logistic adoption to overcome its barriers under fuzzy environtment", *Journal of Manufacturing Systems, Elsevier*, Vol. 37, 2015, pp. 599-615.

[24] S. Bekheet, "An Enhanced Fuzzy Multi Criteria Decision Making Model with a proposed Polygon Fuzzy Number", *International Journal of Advanced Computer Sience and Applications (IJACSA),* Vol. 5, No. 5, 2014, pp. 118-121.

[25] X. Yu, M. Li, Z. Ping, "Multi-Attribute Group Decision Making Based on Biased Informaton Sampling Model and Generalized Trapezoidal Fuzzy Numbers", *12th International Conference on Computer and Information* Technology, 2012, pp. 109-114.

A Hybrid Computation_JATIT.pdf

ORIGINALITY REPORT

8%	6%	6%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Siham Abdulmalik Mohammed Almasani, Valery Ivanovich Finaev, Wadeea Ahmed Abdo Qaid, Alexander Vladimirovich Tychinsky. "The Decision-making Model for the Stock Market under Uncertainty", International Journal of Electrical and Computer Engineering (IJECE), 2017 Publication	1%
2	Wiwien Hadikurniawati, Khabib Mustofa. "Multicriteria Group Decision Making Using Fuzzy Approach for Evaluating Criteria of Electrician", International Journal of Electrical and Computer Engineering (IJECE), 2016 Publication	1%
3	Submitted to Bahcesehir University Student Paper	1%
4	ijiset.com Internet Source	1%
5	polen.itu.edu.tr Internet Source	1%

6	Submitted to Curtin University of Technology Student Paper	1%
7	eashwarpublications.com Internet Source	1%
8	acervodigital.ufpr.br Internet Source	1%
9	Submitted to Thammasat University Student Paper	1%

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		