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Triangular Fuzzy Numbers-based MADM for Selecting Pregnant Mothers at Risk of Stunting

Wiwien Hadikurniawati[1], Kristoko Dwi Hartomo[2], Irwan Sembiring[3], Hindriyanto Dwi Purnomo[4], Ade Iriani[5]
[1,2,3,4,5]Faculty of Information Technology, Universitas Kristen Satya Wacana
[1]982022007@student.uksw.edu, [2]kristoko@uksw.edu, [3]irwan@uksw.edu, [4]hindriyanto.purnomo@uksw.edu, [5]ade.iriani@uksw.edu

Abstract

Stunting is caused by a lack of proper nutrition before and after birth. This research paper identifies and measures the risk of stunting during pregnancy and make recommendations for ranking pregnant women at risk. These aims to provide appropriate treatment and action to reduce mothers giving birth to children at risk of stunting. To make the optimal choice, the selection procedure for pregnant women at risk of giving birth to stunted children considers a variety of factors, including maternal age, maternal nutrition, arms circumference, hemoglobin, parity, birth interval, height, baby weight, and body mass index (BMI). Decision-maker's expectation to reduce uncertainty and imprecision are represented linguistically by triangular fuzzy numbers. The triangular fuzzy numbers arithmetic approach is used to determine the selection process output. The ranking is determined from the alternative with the most parameter values to the alternative with the fewest parameters. Based on the results of the calculation, it was determined that PM (Pregnant Mother) had the highest score and was ranked first. That pregnant mother was declared as pregnant mother who had the lowest risk of giving birth to stunted baby.

Keywords: *stunting; pregnant mother; triangular fuzzy numbers; multi-attribute decision making*

1. Introduction

Stunting is a health issue affecting children, especially in certain regions of the world. It is described as a situation when a child has not grown to their expected height, indicating that the child has not received adFormulauate nutrition or healthcare [1]. The prevalence of stunting in some countries can be very high, with estimates from up to 50% in places like Papua New Guinea and East Timor, 45% in Pakistan, and 40% in Zambia. In other areas, stunting rates are still very high, even if lower than the places mentioned before, such as with India (39%), Nepal (37%), Indonesia (36%), Myanmar (35%), and Tanzania (35%) [2].

Mothers play an important role in preventing stunting in children. Stunting is a serious health problem where a child's growth is stunted, and this can cause long-term health problems. The role of the mother is very important since the child is in the womb and during the golden phase of child development, which includes the preconception, prenatal, and infancy-toddler phases [3]. So far, mothers have played many roles that can help reduce the risk of stunting. This role includes ensuring that the mother and the child-to-be receive proper nutrition so that a balanced mother's weight is obtained that meets BMI standards and avoids potential psychosocial factors that can damage growth and development. In addition, the age factor of pregnant women and the condition of pregnant women greatly affect the growth of a healthy fetus [4].

Multi-Attribute Decision Making (MADM), which is a technique for making decisions. It can be used to pick the best alternative from a group by looking at different criterion (attributes)[5] . MADM is often used in many scientific fields, such as engineering, economics, management, and transportation planning. This technique has been studied by researchers for over 20 years and is often used when decisions need to be made because of the complexity and uncertainty of the situation, as well as the ambiguity of human thinking[6], [7].

Decision makers tend to use intuition and experience more than scientific methods when making complex decisions and do not always provide clear-cut answers

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because of subjective influences. The fuzzy set tool proposed by Zadeh's in 1965 is particularly useful to address this issue, as it provides a way to interpret ambiguous information into meaningful data [8], [9].
The multi-attribute decision method is relatively perfect when the information provided to decide is in the form of the right value, but often in the form of a certain attribute value. Multi-attribute decision making involves a complex process because objective matters may be uncertain and human thinking can be fuzzy. This problem can make it difficult to assign specific values or weights to different attributes. For example, when making decisions based on incomplete information. Studying this kind of decision-making is useful.

The goal of multi attribute decision making is to decide by selecting the best alternative from among many candidates. The process of Multi Attribute Decision Making is typically done in four steps. First, information is gathered to decide. Second, a decision-making model is used to analyze the gathered data and decide. Next, the decision results are acquired. Finally, the best alternative is identified and ranked in a sequence [10]–[12].

Research on multi attribute decision making using fuzzy multi attribute decision making (FMADM) has been developed by many researchers, some of the following studies. [7] in their research proposed an approach, called fuzzy-MADM, which maintains the cost and production advantages of building wind farms while also considering maritime safety issues. This method involves creating decision layers derived from previously identified factors, creating decision matrices, and displaying attribute weight levels using the Analytic Hierarchy Process. The same research on a hybrid trust prediction model known as Fuzzy-Multi Attribute Decision Making (FMADM) was also developed by [13]. This research can provide accurate, trust-based evaluation of cloud services while efficiently handling uncertainty in cloud service valuation data. Research on FMADM was also developed by [14] to determine the effectiveness of using a Decision Support System (DSS) with the Fuzzy Multi-Attribute Decision Making (FMADM) and Simple Additive Weighting (SAW) methods in laptop vendor selection. This study aims to determine whether the two methods are appropriate for making decisions about which laptop vendor to choose, and who is the best candidate.

Research on FMADM using fuzzy triangular developed by [15] The purpose of the paper is to develop a decision-making system for EMUs maintenance that takes into account multiple factors, such as condition, fault history and maintenance conditions. The proposed method uses Triangular Fuzzy multi-Attribute logic to assess these factors in order to select the most optimal scheme from a group of limited faults disposal schemes. This will help improve efficiency and quality of EMU's maintenance while reducing costs. Specifically, triangular fuzzy numbers (TFN) enable decision makers to express their evaluation of an alternative easier and more accurately.

The best alternative was chosen in this study using a multi-attribute fuzzy decision-making technique. To select pregnant mothers with a high risk of stunting, the suggested method uses fuzzy arithmetic and triangular fuzzy numbers.

Triangular fuzzy number (TFN) is used to represent uncertainty or ambiguity in a value or parameter. TFN was chosen because it has many advantages: TFN has an easy-to-understand interpretation because it represents a range of values using three points, TFN is flexible to be used to represent uncertainty in values that can change, TFN has a central value that can be used as a reference point in fuzzy analysis [16], [17].

Attribute values are presented as triangular fuzzy numbers (TFN) in this research, which are used to approximate the rank of alternatives. The rest of the papers are arranged as follows: section 2 discusses research related works. Triangular fuzzy numbers and the fuzzy multi-attribute technique are summarized in section 3. The approach for each technique is also provided in this section. The case study, analysis, and findings of this research are covered in Section 4. Section 5 presents the conclusions.

2. Research Methods

2.1 Triangular Fuzzy Number (TFN)

Triangular fuzzy number is a type of number used by decision makers to rank different alternatives. It is more popular than other types because arithmetic operations are more readily carried out using it. These operations include addition, subtraction, multiplication, division, reciprocal, and geometrical mean, which all help the decision makers determine the rank of the alternatives [18], [19].

Triangular Fuzzy Number (TFN) is represented by three values (known as a1, a2 and a3). It is a way of representing an uncertain numerical value, which is useful in making calculations and decisions that have an element of uncertainty associated with them. The triangular fuzzy numbers are a way of expressing three values, which are represented by $U = (u1, u2, u3)$. This representation of a number includes information about the range of values it could have and its most likely value [20] . This representation is defined by Formula (1).

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$$\mu_{(U)}(x) = \begin{cases} 0, & x < u_1 \\ \frac{x-u_1}{u_2-u_1}, & u_1 \le x \le u_2 \\ \frac{u_3-x}{u_3-u_2}, & u_2 \le x \le u_3 \\ 0, & x > u_3 \end{cases} \quad (1)$$

Formula (2), (3) are steps used to generate the crisp interval obtained by the α-cut operation, interval Uu: [0,1] from ∀α ∈ [0,1].

$$\frac{u_1^{(\propto)} - u_1}{u_2 - u_1} = u\,, \quad \frac{u_3 - u_3^{(\propto)}}{u_3 - u_2} = \propto \quad (2)$$

Then calculated,

$$u_1^{(\propto)} = (u_2 - u_1) \propto + u_1 \quad (3)$$

The equation for U obtained is displayed in Formula (4)

$$U \propto = [u_1^{(\propto)}, u_3^{(\propto)}]$$
$$U \propto = [(u_2 - u_1) \propto + u_1, -\propto + u_3] \quad (4)$$

2.2 Fuzzy Arithmetic

Basic arithmetic operations are operations used to solve simple math problems like addition, subtraction, multiplication, and division. In the context of fuzzy numbers, these operations are extended to use the degree of membership, or how much certain numbers belong to certain categories. Properties of operations on triangular fuzzy numbers are the properties that describe how these extended basic arithmetic operations behave and what they can do [19], [21]

If two fuzzy numbers are added or subtracted, the result is also a fuzzy number. Fuzzy numbers are used when dealing with uncertain or imprecise information and can be represented in the form of a triangle.

Multiplying or dividing two numbers that have been assigned degrees of uncertainty (this is known as triangular fuzzy numbers) does not automatically result in another number with a degree of uncertainty. However, a value approach can be used to convert the result of a multiplication or division operation into triangular fuzzy numbers.

Operation max or min refers to mathematical operations in which a set of numerical values are compared, and the maximum or minimum value is identified. In the context of the paragraph, operation max or min did not produce the desired result. Specifically, the result of the operation was not in the form of a triangular fuzzy number, which is a type of number used in fuzzy logic associated with uncertainty and imprecision.

Some operations on triangular fuzzy numbers (TFN) [21], [22]

Addition, the membership function is not used in this process. For instance, the fuzzy triangular numbers U and V are U = (u1, u2, u3), and V = (v1, v2, v3). U + V are computed utilizing Formula (5).

U + V = (u1, u2, u3) (+) (v1, v2, v3)

U+V= (u1+v1, u2+v2, u3+v3) (5)

Subtraction, if U = (u1, u2, u3) and V = (v1, v2, v3). U – V are determined using Formula (6).

U – V = (u1, u2, u3) (-) (v1, v2, v3)

U – V = (u1-v1, u2-v2, u3-v3) (6)

Multiplication approximation, this technique does not use membership functions, but instead works by using intervals between the two fuzzy numbers. Two crisp intervals are created from each of the fuzzy numbers, and then multiplied together to produce an approximate result which is determined by certain criterions.

There are TFN U = (u1, u2, u3) and V = (v1, v2, v3)

The main concern is α-cuts of 2 fuzzy numbers, as seen in Formula (7)

$$U_\alpha = [(u_2 - u_1)\alpha + u_1, -(u_3 - u_2)\alpha + u_3]$$
$$V_\alpha = [(v_2 - v_1)\alpha + v_1, -(v_3 - v_2)\alpha + v_3] \quad (7)$$

Multiply U by V, which are two crisp intervals with all their components being positive values between [0, 1]. The approximate multiplication formula as presented in Formula (8).

$$U_\alpha (\cdot) V_\alpha = [(u_2 - u_1)\alpha + u_1, -(u_3 - u_2)\alpha + u_3] (\cdot) [(v_2 - v_1)\alpha + v_1, -(v_3 - v_2)\alpha + v_3] \quad (8)$$

The multiplication approximation result U_α (·) V_α determined by α = 0 and α = 1

Division approximation is a triangular fuzzy number that can be used to represent the value of A (/) B. The process for calculating division is identical to that of multiplication. Divide interval A by interval B as a first step.

Formula (9) is shown in for [0, 1].

$$U_\alpha (/) V_\alpha = [(u_2 - u_1)\alpha + u_1 / -(v_3 - v_2)\alpha + v_3, -(v_3 - v_2)\alpha + v_3 / (v_2 - v_1)\alpha + v_1] \quad (9)$$

The division approximation result A_α (·) B_α determined by α = 0 and α = 1.

2.3 *Fuzzy Multi-Attribute Decision Making Approach*

Decision making process, there is often uncertainty or doubt about disclosing perceptions or subjective judgments. Fuzzy set theory is a way to help overcome this uncertainty, ambiguity, and subjectivity by placing decision-making linguistic terms within a mathematical

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framework. This helps provide decision makers with clearer answers to questions.

The decision makers in this situation have some uncertainty and imprecision when they are offering their subjective assessment. This uncertainty happens because the decision makers are not totally and confidently sure of their judgments. To represent these judgments, linguistic variables with fuzzy numbers are used. fuzzy multi attribute decision making is a step-by-step way to minimize that uncertainty and imprecision in the selection process.

Problem Representation is the process of understanding a problem and preparing it to be addressed. It involves the identification of goals and decision alternatives, which is the process of determining which alternative would make the best outcome. It also involves criterion identification, which is the identification of the criterions or characteristics that describe the problem.

Fuzzy set evaluation : Choosing the weights criterion rating set and the degree of fitness for each alternative with its criteria; and Evaluating criterion weights and fitness degrees of any alternative criterions.

Using fuzzy arithmetic to aggregate the criterion weights and fitness degree of each alternative with its criterions, as shown in Formula (10).

$$F_i = [(S_{1i} \otimes W_1) \oplus (S_{2i} \otimes W_2) \oplus \ldots \oplus (S_{ik} \otimes W_k)] \quad (10)$$

Wi is the criterion of Pt's weight. Sit is a fuzzy rating of the fitness of decision option A and criterion Pt. Fi is the fitness degree of alternative decisions represented by a fuzzy match index of alternative Ai. Fi is formed by combining Sit and Wt., where I = 1,2, 3... n and t = 1,2,3,... k.

Select the alternative : Based on the aggregation's results, ranking the various decision alternatives. The ranking of choice options is based on the outcomes of the priority aggregation. Triangular fuzzy numbers are used to represent the outcomes of this aggregate; and Choose a decision alternative that has the highest priority as the optimal alternative.

3. Results and Discussions

The proposed model is used to solve pregnant mothers with stunting risk selection problem.

3.1 Problem Representation

The problem in selecting pregnant women with stunting risk aims to get pregnant women with minimal risk of giving birth to stunted babies. The aim of this research is to get a risk rating for pregnant women, so that pregnant women who are at high risk can be treated appropriately. Healthy pregnant women have a risk of giving birth to healthy babies, so they are expected to avoid stunting toddler growth. Pregnant women who are at risk of giving birth to stunted babies can be minimized by paying attention to the criterion. These criteria are K1 (maternal age), K2 (maternal nutrition), K3 (arms circumference), K4 (hemoglobin), K5 (parity), K6 (birth interval), K7 (height), K8 (baby weight), K9 (BMI). Furthermore, if the mother is still a teenager while pregnant, they are more susceptible to malnutrition, which can also lead to stunting risk. Nutrition monitoring anthropometric for pregnant women involves measuring certain physical characteristics during different periods of pregnancy. In a study, the amount of weight gained each trimester was lower than expected based on the initial measurements such as height, weight, body mass index and upper arm circumference. These measurements are universal indicators of risk during pregnancy, with respective thresholds of below 150 cm for height, below 45kg for weight, below 18.5 kg/m2 for BMI, and below 23.5 for upper arm circumference [23]. These risk factors include the age of the pregnant woman, the number of times she has given birth before, and the interval between pregnancies. There are many risk factors that can contribute to stunting in pregnant women.

3.2 Fuzzy set evaluation

Relevance weights for each criterion are represented by linguistic variables. The weight for each criterion is determined by experts, namely doctors and midwives. Each weight is represented by one of the following triangular fuzzy numbers:

W = [VELO, LO, MED, HI, VH]

Each weight is represented by one of the following triangular fuzzy numbers:

VELO = very low = (0.00, 0.00, 0.25)
LO = low = (0.00, 0.25, 0.50)
MED = medium = (0.25, 0.50, 0.75)
HI = high = (0.50, 0.75, 1.00)
VEHI = very high = (0.75, 1.00, 1.00)

The rating for each decision criterion is shown in Table 1. Table 1 displays the scores for each decision criterion. The value of fuzzy fitness will be determined in the following phase. The results of averaging the different weights of importance for each criterion, as displayed in Table 2

The following decision criterion and alternative fitness levels

S = [VEPO, PO, MED, GO, VEGO]

Each weight is represented by the triangular fuzzy numbers shown below:

VEPO = very poor = (0.00, 0.00, 0.25)
PO = poor = (0.00, 0.25, 0.50)
MED = medium = (0.25, 0.50, 1.00)
GO = good = (0.50, 0.75, 1.00)
VEGO = very good = (0.75, 1.00, 1.00).

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Table 1. Rate of importance for each criterion

Criterion	K1	K2	K3	K4	K5	K6	K7	K8	K9
Importance	HI	VEHI	VELO	HI	MED	MED	LO	VEHI	HI

Table 2. Match rate of each alternative to the criterion

Alternative	Criterion								
	K1	K2	K3	K4	K5	K6	K7	K8	K9
Pregnant Mother 1	VEPO	VEPO	MED	GO	GO	VEGO	PO	PO	PO
Pregnant Mother 2	VEPO	VEGO	MED	MED	PO	MED	GO	VEGO	GO
Pregnant Mother 3	VEGO	VEPO	VEGO	GO	MED	VEGO	PO	PO	MED
Pregnant Mother 4	VEGO	PO	MED	VEGO	GO	VEPO	MED	MED	MED
Pregnant Mother 5	PO	VEPO	MED	GO	GO	VEGO	MED	MED	VEGO
Pregnant Mother 6	PO	PO	GO	VEGO	GO	VEPO	GO	PO	MED
Pregnant Mother 7	PO	GO	MED	PO	PO	GO	VEGO	MED	MED
Pregnant Mother 8	VEPO	VEGO	GO	MED	MED	VEGO	GO	GO	GO
Pregnant Mother 9	VEPO	VEGO	VEGO	MED	VEGO	MED	PO	GO	GO
Pregnant Mother 10	PO	VEGO	MED	GO	GO	GO	MED	VEGO	GO

Alternative 1 (PM 1) : Alternative match rates A1 (pregnant mother 1) of the first criterion is VEPO = (0.00, 0.00, 0.25) and the importance rate for criterion 1 is HI = (0.50, 0.75, 1.00).

Using approximate multiplication on fuzzy arithmetic, fuzzy fitness value is calculated as follows:

U = (0.00, 0.00, 0.25) V = (0.50, 0.75, 1.00)
U_α = [(0.00–0.00)α+0, – (0.25-0.00)α+0.25]
= [0.00, - 0.25α+0.25]
V_α = [(0.75-0.50)α+0.50, - (1.00-0.75)α+1.00]
= [0.25α+0.50, - 0.25α+1.00]
$U_\alpha(\cdot)V_\alpha$= [0.00,-0.25α+0.75]($\cdot$)[0.25α+0.50, - 0.25α+1.00]
= [(0.00) (0.25α+0.50), (-0.25α+0.25)(-0.25α+1.00)]
= [0.00, 0.0625α^2-0.3125α+0.25]
If α = 0, then U_α ($\cdot$) V_α = [0.00, 0.25]
If α = 1, then U_α ($\cdot$) V_α = [0.00, 0.00] = 0.00

Triangular Fuzzy Number (TFN) of U_α ($\cdot$) V_α $\cong$ (0.00, 0.00, 0,25).

Alternative match rates A1 (pregnant mother 1) of the 2nd criterion is VEPO = (0.00, 0.00, 0.25) and the importance rate for criterion 1 is VEHI = (0.75, 1.00, 1.00).

Using approximate multiplication on fuzzy arithmetic, fuzzy fitness value is calculated as follows.

U = (0.00, 0.00, 0.25) V = (0.75, 1.00, 1.00)
U_α = [(0.00–0.00)α+0, – (0.25-0.00)α+0.25]
= [0.00, - 0.25α+0.25]
V_α = [(1.00-0.75)α+0.75, - (1.00-1.00)α+1.00]
= [0.25α+0.75, -2α+1.00]
$U_\alpha(\cdot)V_\alpha$ = [0.00, - 0.25α+0.25] ($\cdot$) [0.25α+0.75, - 2α-1.00]
= [(0.00) (0.25α+0.75), (-0.25α+0.25) (-2α+1.00)]
= [0.00, 0.50α^2-0.25α-0.25]
If α = 0, then U_α ($\cdot$) V_α = [0.00, 0.25]
If α = 1, then U_α ($\cdot$) V_α = [0.00, 0.00] = 0.00

Triangular Fuzzy Number (TFN) of U_α ($\cdot$) V_α $\cong$ (0.00, 0.00, 0,25).

Alternative match rates A1 (pregnant mother 1) of the 3rd criteria is MED = (0.25, 0.50, 0.75) and the importance rate for criteria 1 is VELO = (0.00, 0.00, 0.25).

Using approximate multiplication on fuzzy arithmetic, fuzzy fitness value is calculated as follows:

U = (0.00, 0.00, 0.25) V = (0.75, 1.00, 1.00)
U_α = [(0.50–0.25)α+0.25, – (0.75-0.50)α+0.75]
= [0.25α + 0.25, - 0.25α+0.75]
V_α = [(0.00-0.00)α+0.00, - (0.25-0.00)α+0.25]
= [0.00, - 0.25α+0.25]
U_α ($\cdot$) V_α = [(0.25α + 0.25) (- 0.25α+0.25] ($\cdot$) [0.00, (- 0.25α + 0.75)]
= [-0.0625α^2+0.0625α–0.0625–0.0625α+0.0625), 0.00]
= [- 0.06250α^2 + 0.0625α, 0.00]

If α = 0, then U_α ($\cdot$) V_α = [0.0625, 0.00]
If α = 1, then U_α ($\cdot$) V_α = [0.00, 0.00] = 0.00

Triangular Fuzzy Number (TFN) of U_α ($\cdot$) V_α $\cong$ (0.00, 0.00, 0,0625).

Table 3. The fuzzy match value

Alter native	Criterion								
	K1	K2	K3	K4	K5	K6	K7	K8	K9
PM1 (Pregnant Mother 1)	0, 0, 0.25	0, 0, 0.25	0, 0, 0.0625	0.25, 0.5625, 1	0.125, 0.375, 0.75	0.25, 0.5, 0.5625	0, 0, 0.0625	0.375, 0.5, 0.75	0.25, 0.3125, 0.5
PM2 (Pregnant Mother 2)	0, 0, 0.25	0.75, 0.75, 1	0, 0, 0.0625	0.125, 0.375, 0.75	0.125, 0.375, 0.75	0.1875, 0.1875, 0.375	0.25, 0.3125, 0.5	0.75, 0.75, 1	0.25, 0.5625, 1
PM3 (Pregnant Mother 3)	0.5, 0.75, 0.75	0, 0, 0.25	0, 0, 0.25	0.25, 0.5625, 1	0.1875, 0.1875, 0.375	0.25, 0.5, 0.5625	0, 0, 0.0625	0.375, 0.5, 0.75	0.125, 0.375, 0.75
PM4 (Pregnant Mother 4)	0, 0, 0.25	0.375, 0.5, 0.75	0, 0, 0.0625	0.5, 0.75, 0.75	0.125, 0.375, 0.75	0, 0, 0.0625	0.125, 0.1875, 0.375	0.25, 0.5, 0.5625	0.125, 0.375, 0.75
PM5 (Pregnant Mother 5)	0.25, 0.3125, 0.5	0, 0, 0.25	0, 0, 0.0625	0.25, 0.5625, 1	0.125, 0.375, 0.75	0.25, 0.5, 0.5625	0.125, 0.1875, 0.375	0.25, 0.5, 0.5625	0.5, 0.75, 0.75
PM6 (Pregnant Mother 6)	0.25, 0.3125, 0.5	0.375, 0.5, 0.75	0, 0, 0.125	0.5, 0.75, 0.75	0.125, 0.375, 0.75	0, 0, 0.0625	0.25, 0.3125, 0.5	0.375, 0.5, 0.75	0.125, 0.375, 0.75
PM7 (Pregnant Mother 7)	0.25, 0.3125, 0.5	0.5, 0.75, 0.75	0, 0, 0.0625	0.25, 0.3125, 0.5	0.125, 0.1875, 0.375	0.125, 0.375, 0.75	0.375, 0.5, 0.75	0.25, 0.5, 0.5625	0.125, 0.375, 0.75
PM8 (Pregnant Mother 8)	0, 0, 0.25	0.75, 0.75, 1	0, 0, 0,125	0.125, 0.375, 0.75	0.25, 0.5, 0.5625	0.25, 0.3125, 0.5	0.5, 0.75, 0.75	0.5, 0.75, 0.75	0.25, 0.5625, 1
PM9 (Pregnant Mother 9)	0, 0, 0.25	0.75, 0.75, 1	0, 0, 0.25	0.125, 0.375, 0.75	0.25, 0.5, 0.5625	0.1875, 0.1875, 0.375	0, 0, 0.0625	0.5, 0.75, 0.75	0.25, 0.5625, 1
PM10 (Pregnant Mother 10)	0.25, 0.3125, 0.5	0.75, 0.75, 1	0, 0, 0.0625	0.25, 0.5625, 1	0.125, 0.375, 0.75	0.125, 0.375, 0.75	0.125, 0.1875, 0.375	0.75, 0.75, 1	0.25, 0.5625, 1

Table 4. The alternative ranking result

Alternative	Weight	Rank
PM1 (Pregnant Mother 1)	0.1388, 0.2500, 0.4650	10
PM2 (Pregnant Mother 2)	0.2708, 0.3472, 0.5903	2
PM3 (Pregnant Mother 3)	0.1875, 0.3194, 0.5278	8
PM4 (Pregnant Mother 4)	0.1667, 0.2986, 0.4790	9
PM5 (Pregnant Mother 5)	0.1944, 0.3542, 0.5347	7
PM6 (Pregnant Mother 6)	0.2222, 0.3486. 0.5486	6
PM7 (Pregnant Mother 7)	0.2222, 0.3680. 0.5555	4
PM8 (Pregnant Mother 8)	0.2569, 0.3819, 0.5792	3
PM9 (Pregnant Mother 9)	0.2292, 0.3472, 0.5555	5
PM10 (Pregnant Mother 10)	0.2917, 0.3750, 0.6819	1

The same techniques as the previous computation can be used to estimate the Triangular Fuzzy Number (TFN) of the alternate weight to additional criteria. Table 3 displays the results of the fuzzy fitness value computation for each alternative toward criterion.

3.3 Alternatives Evaluation

The ranking is determined by going from the alternatives with the most parameters to the ones with the fewest. Table 4 displays the result.

Based on the calculation results obtained PM (Pregnant Mother) 10 has the highest value and is ranked first. PM is declared as a pregnant mother who has the smallest risk of giving birth to a stunted baby. PM 10 was declared the best pregnant woman among other risky pregnant women.

4. Conclusion

The process of evaluating and determining pregnant mothers who are at risk of giving birth to stunted children usually involves many factors. This study analyses ways to make decisions based on these factors by understanding that experts have different preferences and opinions. To complete the determination of pregnant mothers who are at risk of giving birth to stunted children, an arithmetic approach that uses "triangular fuzzy numbers". These systems use language and numbers to help explain the preferences of decision makers and help reduce the uncertainty that arises from making decisions. The results of these analyses and calculations will provide the best options for making decisions, ranking pregnant mothers who are at risk.

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References

[1] C. Berti and A. la Vecchia, "Temporal trend of child stunting prevalence and Food and Nutritional Surveillance System," *J Pediatr (Rio J)*, 2022, doi: 10.1016/j.jped.2022.10.001.

[2] S. H. Quamme and P. O. Iversen, "Prevalence of child stunting in Sub-Saharan Africa and its risk factors," *Clinical Nutrition Open Science*, vol. 42. Elsevier B.V., pp. 49–61, Apr. 01, 2022. doi: 10.1016/j.nutos.2022.01.009.

[3] V. T. Siy Van *et al.*, "Predicting undernutrition among elementary schoolchildren in the Philippines using machine learning algorithms," *Nutrition*, vol. 96, Apr. 2022, doi: 10.1016/j.nut.2021.111571.

[4] M. Zhong, H. Zhang, C. Yu, J. Jiang, and X. Duan, "Application of machine learning in predicting the risk of postpartum depression: A systematic review," *Journal of Affective Disorders*, vol. 318. Elsevier B.V., pp. 364–379, Dec. 01, 2022. doi: 10.1016/j.jad.2022.08.070.

[5] J. Wu and E. C. C. Tsang, "A New Three-way Multi-attribute Decision Making Based on Regret Theory and TOPSIS Model," in *International Conference on Wavelet Analysis and Pattern Recognition*, 2022, vol. 2022-September, pp. 66–71. doi: 10.1109/ICWAPR56446.2022.9947194.

[6] W. Zayat, H. S. Kilic, A. S. Yalcin, S. Zaim, and D. Delen, "Application of MADM methods in Industry 4.0: A literature review," *Comput Ind Eng*, vol. 177, p. 109075, Mar. 2023, doi: 10.1016/j.cie.2023.109075.

[7] B. Wu, T. L. Yip, L. Xie, and Y. Wang, "A fuzzy-MADM based approach for site selection of offshore wind farm in busy waterways in China," *Ocean Engineering*, vol. 168, pp. 121–132, Nov. 2018, doi: 10.1016/j.oceaneng.2018.08.065.

[8] B. Wu, T. L. Yip, L. Xie, and Y. Wang, "A fuzzy-MADM based approach for site selection of offshore wind farm in busy waterways in China," *Ocean Engineering*, vol. 168, pp. 121–132, Nov. 2018, doi: 10.1016/j.oceaneng.2018.08.065.

[9] M. Amiri-Aref, N. Javadian, and M. Kazemi, "A new fuzzy positive and negative ideal solution for fuzzy TOPSIS," *WSEAS Transactions on Circuits and Systems*, vol. 11, no. 3, pp. 92–103, 2012.

[10] G. Büyüközkan and G. Çifçi, "A novel hybrid MCDM approach based on fuzzy DEMATEL, fuzzy ANP and fuzzy TOPSIS to evaluate green suppliers," *Expert Syst Appl*, vol. 39, no. 3, pp. 3000–3011, Feb. 2012, doi: 10.1016/j.eswa.2011.08.162.

[11] M. Li, L. Liu, and C.-B. Li, "An approach to expert recommendation based on fuzzy linguistic method and fuzzy text classification in knowledge management systems," *Expert Syst Appl*, vol. 38, no. 7, pp. 8586–8596, Jul. 2011, doi: 10.1016/j.eswa.2011.01.062.

[12] H. Ho, "A novel fuzzy group decision making model for building an intelligent rating system," *2013 10th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD)*, pp. 1110–1114, Jul. 2013, doi: 10.1109/FSKD.2013.6816363.

[13] O. Gireesha, A. B. Kamalesh, K. Krithivasan, and V. S. Shankar Sriram, "A Fuzzy-Multi Attribute Decision Making approach for efficient service selection in cloud environments," *Expert Syst Appl*, vol. 206, Nov. 2022, doi: 10.1016/j.eswa.2022.117526.

[14] A. Diana, "Decision Support System with Fuzzy Multi-Attribute Decision Making (FMADM) and Simple Additive Weighting (SAW) In Laptop Vendor Selection."

[15] L. Li, H. Wang, P. Sun, and Y. Chen, "Research on Decision-Making of EMUs Maintenance Based on Triangular Fuzzy multi-Attribute," in *Proceedings - 2021 International Conference on Artificial Intelligence and Blockchain Technology, AIBT 2021*, 2021, pp. 17–20. doi: 10.1109/AIBT53261.2021.00010.

[16] N. Saini, R. K. Bajaj, N. Gandotra, and R. P. Dwivedi, "Multi-criteria Decision Making with Triangular Intuitionistic Fuzzy Number based on Distance Measure & Parametric Entropy Approach," in *Procedia Computer Science*, 2018, vol. 125, pp. 34–41. doi: 10.1016/j.procs.2017.12.007.

[17] A. Ghaffari, R. Saadati, and R. Mesiar, "Fuzzy number-valued triangular norm-based decomposable time-stamped fuzzy measure and integration," *Fuzzy Sets Syst*, vol. 430, pp. 144–173, Feb. 2022, doi: 10.1016/j.fss.2021.03.018.

[18] F. Wang, "Preference degree of triangular fuzzy numbers and its application to multi-attribute group decision making," *Expert Syst Appl*, vol. 178, Sep. 2021, doi: 10.1016/j.eswa.2021.114982.

[19] L. Araque, L. Wang, A. Mal, and C. Schaal, "Advanced fuzzy arithmetic for material characterization of composites using guided ultrasonic waves," *Mech Syst Signal Process*, vol. 171, May 2022, doi: 10.1016/j.ymssp.2022.108856.

[20] W. Hadikurniawati and K. Mustofa, "Multicriteria group decision making using fuzzy approach for evaluating criteria of electrician," *International Journal of Electrical and Computer Engineering*, vol. 6, no. 5, 2016, doi: 10.11591/ijece.v6i5.10946.

[21] Y. T. İç and M. Yurdakul, "A new long term (strategic) ranking model for machining center selection decisions based on the review of machining center structural components using triangular fuzzy numbers," *Decision Analytics Journal*, vol. 4, p. 100081, Sep. 2022, doi: 10.1016/j.dajour.2022.100081.

[22] W. Hadikurniawati, R. Wardoyo, and U. Gadjah Mada, "A Multi-Attribute Decision Making for Electrician Selection using Triangular Fuzzy Numbers Arithmetic Approach," 2015. [Online]. Available: www.ijacsa.thesai.org

[23] A. Saleh, S. Syahrul, V. Hadju, I. Andriani, and I. Restika, "Role of Maternal in Preventing Stunting: a Systematic Review," *Gac Sanit*, vol. 35, pp. S576–S582, Jan. 2021, doi: 10.1016/j.gaceta.2021.10.087.