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Decision-making using fuzzy TOPSIS for selecting beginner UMKM that receive business funding

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Abstract. *"Usaha Kecil Mikro dan Menengah"* (UMKM) is a productive business unit of individuals or business entities in each economic sector. Currently, many UMKMs face difficulty in developing their business due to a lack of working capital. Therefore, the government provides business funding for the UMKM through *"Dinas Koperasi dan UMKM"* (Diskopum). Diskopum has various business funding; one of them is business funding for a beginner UMKM. The beginner UMKM that can get the business funding must complete the requirements that Diskopum requested. Among the requirements requested, there are several fuzzy criteria. This research solves the problem of determining the business funding for the beginner UMKM using the fuzzy TOPSIS method. The method was chosen because the output is in the form of ranking. Since the data used in this study is the submission data from 2019, the data already has the actual results. There are several differences between the actual ranking and the result using the fuzzy TOPSIS method, but the difference is insignificant. That result proved that the fuzzy TOPSIS method could determine the ranking of the business capital fund as an alternative method.

1. Introduction

Usaha Mikro Kecil dan Menengah (UMKM) is a productive business unit of individuals or business entities in every economic sector [3]. Someone who runs UMKM is called an entrepreneur. Nowadays, many young entrepreneurs have problems developing their businesses due to a lack of working capital. Therefore, the government provides business funding for the UMKM through "Dinas Koperasi dan UMKM" (Diskopum). Diskopum has various business funding; one of them is business funding for a beginner UMKM. The beginner UMKM that can get the business funding must complete the requirements that Diskopum requested. The requirements are a) the maximum age of the business owner is 45 years old, b) the duration of the business is a minimum of 6 months and a maximum of 3 years, c) is an Indonesian citizen, d) has a Taxpayer Identification Number (NPWP), e) a minimum of education in junior high school, and f) submission of business development plan proposals. Among the requirements requested, there are several fuzzy criteria, such as the business owner's age, the duration of the business, and the submission of the business development plan.

Fuzzy means something vague, uncertain, or unclear [2]. To overcome the ambiguity in some fuzzy things, then there is the concept of fuzzy logic. Unlike Boolean logic with the output value of 0 or 1, fuzzy logic has an output value with a range of 0 to 1 [4]. That value is represented through linguistic variables. A linguistic variable is a variable written using a familiar word like young, middle-aged, and adult. While the numeric variable is written using numbers [1].

The fuzzy TOPSIS method is one of the methods of Multi-Criteria Decision Making [2]. This method is also popular in designing a decision-making system because of the modest concept. The output is a ranking from the best-chosen alternative with the smallest distance from the positive ideal solution and the longest distance from the negative ideal solution [1]. The alternative ranking is obtained by determining several kinds of criteria that are used first. The following process is to normalize and weighted each criterion. After that, we can get the ranking result by deciding the solution ideal value and counting the distance of each alternative with the solution ideal [5].

This research used the fuzzy TOPSIS method to select beginner UMKM that receive business funding. This topic was chosen because there are many entrepreneurs in Kabupaten Jember who want to get business funding. Diskopum needs to verify and evaluate the submitted requirements, so the system and method will help Diskopum get the final result needed. Because of that. The fuzzy TOPSIS method is chosen because the result is ranking.

2. Research method

2.1. Research data

The researchers used the data from the submission of beginner UMKM business capital assistance in 2019 through the Jember Diskopum. The data used as a criterion for this research are the business owner's age, the duration of the business, the business's income per month, and the quality of the business development plan. The assessment team from Diskopum Jember has evaluated those data. The assessment processwas done by filling out the assessment form provided by the author. The assessor assessed the quality of the proposal by assessing the contents of the proposal submitted regarding how the potential of the proposed business can develop if the company receives business capital assistance. The assessment team has assessed objectively using the linguistic variable. The linguistic variable for each criterion is shown in Table 1.

Table 1. The linguistic variable for each criterion.

Criteria	**Linguistic Variable**		
Business Owner's age	Productive Enough (PE)	Productive (P)	Very Productive (VP)
Business Income per month	Low (L)	Average (A)	High (H)
The duration of the business	New (N)	Quite Old (QO)	Old (O)
Quality of the business plan	Quite Goof (QG)	Good (G)	Very Good (VG)

Each criterion will also be given a weight using the linguistic variables "Very Important (VI),""Important (I),""Quite Important (SI),""Less Important (LI)," and "Not Important (NI)." Each linguistic variable has a membership value represented using a triangular curve so that each membership value has an element (a; b; c). The membership value uses a triangular curve for the weight of each criterion. It is shown in Figure 1.

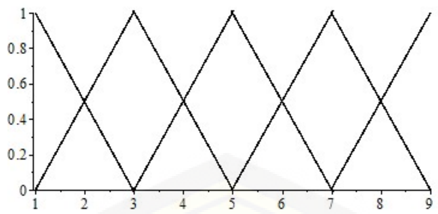

Figure 1. Curve for the weight of each criterion.

Membership value for the weight of another linguistic variable is described in Table 2.

Table 2. Membership value for the weight of the criterion

Linguistic Variable	Membership value
Not Important (NI)	(1;1;3)
Less Important (LI)	(1;3;5)
Quite Important (QI)	(3;5;7)
Important (I)	(5;7;9)
Very Important (VI)	(7;9;9)

The membership value for each linguistic variable on every criterion is shown in Figure 2 and Table 3.

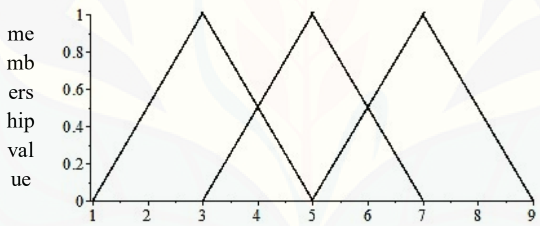

Figure 2. The membership value curve of business owner's age criteria.

Table 3. Membership value of each criterion.

No.	Business owner's age	The business income per month	The duration of the business	Quality of the business plan	Membership value
1.	Quite Productive	Low	New	Quite Good	(1;3;5)
2.	Productive	Average	Quite Old	Good	(3;5;7)
3.	Very Productive	High	Old	Very Good	(5;7;9)

2.2. Processing the data with fuzzy TOPSIS method

2.2.1. Determine the decision matrix. In determining the candidate for the business fund, let $m$be the candidate with n criteria and k be the decision-maker. The value of the data of each k decision-maker to the j^{th} criteria by the i^{th}-candidate is denoted by x_{ij}^{k}, where$i = 1,2,\dots,m$; $j = 1,2,\dots,n$. From that statement, the decision matrix of the following k-th data is obtained as follows:

$$M^k = \begin{bmatrix} x_{11}^k & x_{12}^k & \cdots & x_{1n}^k \\ x_{21}^k & x_{22}^k & & x_{21}^k \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1}^k & x_{m2}^k & \cdots & x_{mn}^k \end{bmatrix}$$

Everyx_{ij} has elementa_{ij}; b_{ij}; c_{ij}, so it is defined as:

$$a_{ij} = \min_k\{a_{ij}^k\}, b_{ij} = \frac{1}{K}\sum_{k=1}^{K} b_{ij}^k, c_{ij} = \max_k\{c_{ij}^k\} \quad (1)$$

So that the following decision matrix M is obtained as follows:

$$M = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}$$

2.2.2. Compute the normalized fuzzy decision matrix. The normalized fuzzy decision matrix is $R = [r_{ij}]_{m\times n}$, where

$$r_{ij} = \left(\frac{c_j^-}{a_{ij}}, \frac{c_j^-}{b_{ij}}, \frac{c_j^-}{c_{ij}}\right), c_j^- = \min_i a_{ij} \quad (2)$$

for cost criteria or

$$r_{ij} = \left(\frac{a_{ij}}{c_j^+}, \frac{b_{ij}}{c_j^+}, \frac{c_{ij}}{c_j^+}\right), c_j^+ = \max_i c_{ij} \quad (3)$$

for benefit criteria.

2.2.3. Compute the weighted normalize fuzzy decision matrix. Let $W^k = [w_1^k \quad w_2^k \quad \dots \quad w_j^k]$ as a weight vector of $j = 1,2,\dots,n$criteria given by each decision maker $K = 1..k$. Each value of w_j has element a_{j1}; b_{j2}; c_{j3}, so it is defined as:

$$a_{j1} = \min_k\{a_{j1}^k\}, b_{j2} = \frac{1}{K}\sum_{k=1}^{K}(b_{j2}^k), c_{j3} = \max_k\{c_{j3}^k\} \quad (4)$$

Then we get the weight vector of the criteria $W = [w_1 \quad w_2 \quad \cdots \quad w_j]$. The weighted normalized fuzzy decision matrix is $V = (v_{ij})$, where

$$v_{ij} = w_j \times r_{ij} \quad (5)$$

So that the following weighted normalized fuzzy V matrix is obtained as follows:

$$V = \begin{bmatrix} v_{11} & v_{12} & \cdots & v_{1n} \\ v_{21} & v_{22} & & v_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ v_{m1} & v_{m2} & \cdots & v_{mn} \end{bmatrix} \quad (6)$$

2.2.4. Compute the Fuzzy Positive Ideal Solution (FPIS) and Fuzzy Negative Ideal Solution (FNIS). The positive ideal values of $A^+$and negative $A^-$of the weighted normal decision matrix $V$are:

$$A^+ = (v_1^+, v_2^+, \dots, v_n^+), \quad v_j^+ = max_i\{v_{ij}\}$$
$$A^- = (v_1^-, v_2^-, \dots, v_n^-), \quad v_j^- = \min_i\{v_{ij}\} \quad (7)$$

2.2.5. Compute the distance from each alternative to the FPIS and the FNIS. Calculates the distance between each element of the matrix V and each element of the vector A^+ and A^-so that we get matrices D^+ and D^-using equations (7) and (8). Let $v_{ij} = (a_1; b_1; c_1)$and $v_j^+ = v_j^- = (a_2; b_2; c_2)$ then:

$$D^+ = d\left(v_{ij}, v_j^+\right) = \sqrt{\frac{1}{3}[(a_1 - a_2)^2 + (b_1 - b_2)^2 + (c_1 - c_2)^2]} \quad (8)$$

$$D^- = d\left(v_{ij}, v_j^-\right) = \sqrt{\frac{1}{3}[(a_1 - a_2)^2 + (b_1 - b_2)^2 + (c_1 - c_2)^2]} \quad (9)$$

Then calculate the distance of each alternative on D^+using equation(9) and on $D^-$with equation (10).

$$d_i^+ = \sum_{j=1}^{n} d(v_{ij}, v_j^+) \quad (10)$$

$$d_i^- = \sum_{j=1}^{n} d(v_{ij}, v_j^-) \quad (11)$$

2.2.6. Compute the closeness coefficient CC_i for each alternative. The closeness coefficient CC_i of the I alternative to the distance value d_i^+ and d_i^- is calculated using the following equation:

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad (12)$$

2.2.7. Rank the alternatives. The ranking is determined based on the closeness coefficient CC_i. The alternatives that have the most significant value are going to be the first rank.

3. Implementation in data and results

3.1. Implementation in data

The data used in this study are shown in Table 4 below. Table 4 explains the detail of beginner UMKM business capital assistance submission in 2019 through the Jember Diskopum. Code A1 until A19 represents the nineteen candidates.

Table 4. The data of the candidate.

Code	Name	Business owner's age	The business income per month	The duration of the business	Quality of the business plan
A1	Helmi Zamrudiansyah	38 years old	8.800.000	1,5 years	Exist
A2	Moh Khotib	38 years old	4.337.000	2 years	Exist
A3	Arie Cahyana	32 years old	7.461.000	1 years	Exist
A4	Intan Purnama Sari	31 years old	155.000	2 years	Exist
A5	Heru Setiyo Wicaksono	31 years old	14.000.000	8 months	Exist
A6	Wanitari Afiat	33 years old	1.500.000	2 years	Exist
A7	Ermawati Ningsih	44 years old	500.000	1 years	Exist
A8	Azhur Karomiyah	37 years old	6.000.000	2 years	Exist
A9	Defvi Trisna Widhandayani	29 years old	7.310.000	6 months	Exist
A10	Widianingsih	32 years old	6.500.000	2 years	Exist
A11	Sudarmaji	42 years old	2.216.000	1,6 years	Exist
A12	Dian Nita	33 years old	4.339.000	2 years	Exist
A13	Mukmina	30 years old	7.500.000	1 year	Exist
A14	Fajar Hikmawan	41 years old	3.500.000	10 months	Exist
A15	Purining Ratri Muktisari	38 years old	6.225.000	2 years	Exist
A16	Nawang Fitria	39 years old	4.180.000	3 years	Exist
A17	Yurnita Mandasari	42 years old	2.000.000	2 years	Exist
A18	Trias Setyawati	43 years old	8.800.000	2 years	Exist
A19	Guntur Wibowo	38 years old	5.000.000	2 years	Exist

The assessment team assessed the data in Table 4 using linguistic variables. The results of the assessment from each assessor will be converted into a matrix M_1, M_2 and M_3,. After obtaining the values of each matrix M_1, M_2 and M_3, then the calculation process using fuzzy TOPSIS is carried out with the following steps:

3.1.1. Determine the decision matrix M using equation (1). The calculating process starts from $x_{1,1}$to$x_{19,4}$so that matrix$M_{19,4}$is obtained as follows:

$$M = \begin{bmatrix} (3;5,67;9) & (5;7,00;9) & (1;4,33;7) & (3;5,00;7) \\ (1;3,67;7) & (1;3,67;7) & (3;6,33;9) & (1;4,33;7) \\ (3;6,33;9) & (3;5,00;7) & (1;3,00;5) & (1;5,00;9) \\ (1;4,33;9) & (1;3,00;5) & (3;6,33;9) & (1;4,33;9) \\ (3;6,33;9) & (5;7,00;9) & (1;3,00;5) & (3;5,67;9) \\ (3;6,33;9) & (1;3,00;5) & (3;6,33;5) & (1;5,00;9) \\ (1;3,00;5) & (1;3,00;5) & (1;3,67;7) & (3;5,67;9) \\ (3;5,00;7) & (3;5,67;9) & (3;5,00;7) & (1;3,67;7) \\ (5;7,00;9) & (3;5,00;7) & (1;3,67;7) & (3;6,33;9) \\ (3;6,33;9) & (3;5,00;7) & (1;4,33;7) & (1;5,67;9) \\ (1;3,00;5) & (1;3,67;7) & (1;4,33;7) & (1;4,33;7) \\ (3;6,33;9) & (1;4,33;7) & (3;6,33;9) & (3;6,33;9) \\ (5;7,00;9) & (3;5,00;7) & (1;3,00;5) & (3;6,33;9) \\ (1;5,00;9) & (1;3,67;7) & (1;3,67;7) & (3;5,67;9) \\ (3;5,67;9) & (3;5,00;7) & (3;5,00;7) & (1;5,67;9) \\ (1;4,33;7) & (1;4,33;7) & (5;7,00;9) & (1;5,00;9) \\ (1;3,67;7) & (1;3,67;7) & (3;5,00;7) & (1;4,33;9) \\ (1;3,00;5) & (3;5,00;7) & (3;5,67;9) & (1;4,33;7) \\ (1;3,67;7) & (1;4,33;7) & (3;6,33;9) & (1;5,00;9) \end{bmatrix}$$

3.1.2. Compute the normalized fuzzy decision matrix using equation (2) and (3), so that matrix *R* is obtained as follows:

$$R = \begin{bmatrix} (0,33;0,18;0,11) & (0,20;0,14;0,11) & (0,11;0,48;0,78) & (0,33;0,56;0,78) \\ (1,00;0,27;0,14) & (1,00;0,27;0,14) & (0,33;0,70;1,00) & (0,11;0,48;0,78) \\ (0,33;0,16;0,11) & (0,33;0,20;0,14) & (0,11;0,33;0,56) & (0,11;0,56;1,00) \\ (1,00;0,23;0,11) & (1,00;0,33;0,20) & (0,33;0,70;1,00) & (0,11;0,48;1,00) \\ (0,33;0,16;0,11) & (0,20;0,14;0,11) & (0,11;0,33;0,56) & (0,33;0,63;1,00) \\ (0,33;0,16;0,11) & (1,00;0,33;0,20) & (0,33;0,70;1,00) & (0,11;0,56;1,00) \\ (1,00;0,33;0,20) & (1,00;0,33;0,20) & (0,11;0,4;0,78) & (0,33;0,63;1,00) \\ (0,33;0,20;0,14) & (0,33;0,18;0,11) & (0,33;0,56;0,78) & (0,11;0,41;0,78) \\ (0,20;0,14;0,11) & (0,33;0,20;0,14) & (0,11;0,41;0,78) & (0,33;0,70;1,00) \\ (0,33;0,16;0,11) & (0,33;0,20;0,14) & (0,11;0,48;0,78) & (0,11;0,63;1,00) \\ (1,00;0,33;0,20) & (1,00;0,27;0,14) & (0,11;0,48;0,78) & (0,11;0,48;0,78) \\ (0,33;0,16;0,11) & (1,00;0,23;0,14) & (0,33;0,70;1,00) & (0,33;0,70;1,00) \\ (0,20;0,14;0,11) & (0,33;0,20;0,14) & (0,11;0,33;0,56) & (0,33;0,70;1,00) \\ (1,00;0,20;0,11) & (1,00;0,27;0,14) & (0,11;0,41;0,78) & (0,33;0,63;1,00) \\ (0,33;0,18;0,11) & (0,33;0,20;0,14) & (0,33;0,56;0,78) & (0,11;0,63;1,00) \\ (1,00;0,23;0,14) & (1,00;0,23;0,14) & (0,56;0,78;1,00) & (0,11;0,56;1,00) \\ (1,00;0,27;0,14) & (1,00;0,27;0,14) & (0,33;0,56;0,78) & (0,11;0,48;1,00) \\ (1,00;0,33;0,20) & (0,33;0,20;0,14) & (0,33;0,63;1,00) & (0,11;0,48;0,78) \\ (1,00;0,27;0,14) & (1,00;0,23;0,14) & (0,33;0,70;1,00) & (0,11;0,56;1,00) \end{bmatrix}$$

3.1.3. Compute the weighted normalized fuzzy decision matrix. The weight of each criterion is shown at the vector below

$$w_1 = \begin{bmatrix} (5;7;9) \\ (7;9;9) \\ (7;9;9) \end{bmatrix} w_2 = \begin{bmatrix} (7;9;9) \\ (5;7;9) \\ (5;7;9) \end{bmatrix}$$

$$w_3 = \begin{bmatrix} (7;9;9) \\ (5;7;9) \\ (3;5;7) \end{bmatrix} w_4 = \begin{bmatrix} (3;5;7) \\ (5;7;9) \\ (7;9;9) \end{bmatrix}$$

Then using equation (4) so that vector W is obtained as follows:

$$W = [w_1 w_2 w_3 w_4]$$

$$W = [(5;8{,}33;9) \quad (5;7{,}67;9) \quad (3;7{,}00;9) \quad (3;7{,}00;9)]$$

After matrix R and W are obtained, then use equation (5), so that matrix V obtained as follows:

$$V = \begin{bmatrix}
(1{,}67;1{,}47;1{,}00) & (1{,}00;1{,}10;1{,}00) & (0{,}33;3{,}37;7{,}00) & (1{,}00;3{,}89;7{,}00) \\
(5{,}00;2{,}27;1{,}29) & (5{,}00;2{,}09;1{,}29) & (1{,}00;4{,}93;9{,}00) & (0{,}33;3{,}37;7{,}00) \\
(1{,}67;1{,}32;1{,}00) & (1{,}67;1{,}53;1{,}29) & (0{,}33;2{,}33;5{,}00) & (0{,}33;3{,}89;9{,}00) \\
(5{,}00;1{,}92;1{,}00) & (5{,}00;2{,}56;1{,}80) & (1{,}00;4{,}93;9{,}00) & (0{,}33;3{,}37;9{,}00) \\
(1{,}67;1{,}32;1{,}00) & (1{,}00;1{,}10;1{,}00) & (0{,}33;2{,}33;5{,}00) & (1{,}00;4{,}41;9{,}00) \\
(1{,}67;1{,}32;1{,}00) & (5{,}00;2{,}56;1{,}80) & (1{,}00;4{,}93;9{,}00) & (0{,}33;3{,}89;9{,}00) \\
(5{,}00;2{,}78;1{,}80) & (5{,}00;2{,}56;1{,}80) & (0{,}33;2{,}85;7{,}00) & (1{,}00;4{,}41;9{,}00) \\
(1{,}67;1{,}67;1{,}29) & (1{,}67;1{,}35;1{,}00) & (1{,}00;3{,}89;7{,}00) & (0{,}33;2{,}85;7{,}00) \\
(1{,}00;1{,}19;1{,}00) & (1{,}67;1{,}53;1{,}29) & (0{,}33;2{,}85;7{,}00) & (1{,}00;4{,}93;9{,}00) \\
(1{,}67;1{,}32;1{,}00) & (1{,}67;1{,}53;1{,}29) & (0{,}33;3{,}37;7{,}00) & (0{,}33;4{,}41;9{,}00) \\
(5{,}00;2{,}78;1{,}80) & (5{,}00;2{,}09;1{,}29) & (0{,}33;3{,}37;7{,}00) & (0{,}33;3{,}37;7{,}00) \\
(1{,}67;1{,}32;1{,}00) & (5{,}00;1{,}77;1{,}29) & (1{,}00;4{,}93;9{,}00) & (1{,}00;4{,}93;9{,}00) \\
(1{,}00;1{,}19;1{,}00) & (1{,}67;1{,}53;1{,}29) & (0{,}33;2{,}33;5{,}00) & (1{,}00;4{,}93;9{,}00) \\
(5{,}00;1{,}67;1{,}00) & (5{,}00;2{,}09;1{,}29) & (0{,}33;2{,}85;7{,}00) & (1{,}00;4{,}41;9{,}00) \\
(1{,}67;1{,}47;1{,}00) & (1{,}67;1{,}53;1{,}29) & (1{,}00;3{,}89;7{,}00) & (0{,}33;4{,}41;9{,}00) \\
(5{,}00;1{,}92;1{,}29) & (5{,}00;1{,}77;1{,}29) & (1{,}67;5{,}44;9{,}00) & (0{,}33;3{,}89;9{,}00) \\
(5{,}00;2{,}27;1{,}29) & (5{,}00;2{,}09;1{,}29) & (1{,}00;3{,}89;7{,}00) & (0{,}33;3{,}37;9{,}00) \\
(5{,}00;2{,}78;1{,}80) & (1{,}67;1{,}53;1{,}29) & (1{,}00;4{,}41;9{,}00) & (0{,}33;3{,}37;7{,}00) \\
(5{,}00;2{,}27;1{,}29) & (5{,}00;1{,}77;1{,}29) & (1{,}00;4{,}93;9{,}00) & (0{,}33;3{,}89;9{,}00)
\end{bmatrix}$$

3.1.4. Compute the Fuzzy Positive Ideal Solution (FPIS) using equation (6) and Fuzzy Negative Ideal Solution (FNIS) using equation (7) so that vector A^+ *and* A^- are obtained as follows:

$$A^+ = [(5{,}00;2{,}78;1{,}80) \quad (5{,}00;2{,}56;1{,}80) \quad (1{,}67;5{,}44;9{,}00) \quad (1{,}00;4{,}93;9{,}00)]$$

$$A^- = [(1{,}00;1{,}19;1{,}00) \quad (1{,}00;1{,}10;1{,}00) \quad (0{,}33;2{,}33;5{,}00) \quad (0{,}33;2{,}85;7{,}00)]$$

3.1.5. Compute the distance from each alternative to the FPIS and the FNIS. Use equations (8) and (9) so that matrix D^+ and D^- are obtained as follows:

$$D^+ = \begin{bmatrix}
2{,}12 & 2{,}50 & 1{,}83 & 1{,}30 \\
0{,}42 & 0{,}40 & 0{,}49 & 1{,}51 \\
2{,}15 & 2{,}04 & 3{,}03 & 0{,}71 \\
0{,}68 & 0{,}00 & 0{,}49 & 0{,}98 \\
2{,}15 & 2{,}50 & 3{,}03 & 0{,}30 \\
2{,}15 & 0{,}00 & 0{,}49 & 0{,}71 \\
0{,}00 & 0{,}00 & 2{,}04 & 0{,}30 \\
2{,}05 & 2{,}10 & 1{,}51 & 0{,}71 \\
2{,}53 & 2{,}04 & 2{,}04 & 0{,}00 \\
2{,}15 & 2{,}04 & 1{,}83 & 0{,}49 \\
0{,}00 & 0{,}40 & 1{,}83 & 1{,}51 \\
2{,}15 & 0{,}54 & 0{,}49 & 0{,}00 \\
2{,}53 & 2{,}04 & 3{,}03 & 0{,}00 \\
0{,}79 & 0{,}40 & 2{,}04 & 0{,}30 \\
2{,}12 & 2{,}04 & 1{,}51 & 0{,}49 \\
0{,}58 & 0{,}54 & 0{,}00 & 0{,}71 \\
0{,}42 & 0{,}40 & 1{,}51 & 0{,}98 \\
0{,}00 & 2{,}04 & 0{,}71 & 1{,}51 \\
0{,}42 & 0{,}54 & 0{,}49 & 0{,}71
\end{bmatrix}
D^- = \begin{bmatrix}
0{,}42 & 0{,}00 & 1{,}20 & 0{,}71 \\
2{,}40 & 2{,}38 & 2{,}78 & 0{,}30 \\
0{,}39 & 0{,}49 & 0{,}00 & 1{,}30 \\
2{,}35 & 2{,}50 & 2{,}78 & 1{,}19 \\
0{,}39 & 0{,}00 & 0{,}00 & 1{,}51 \\
0{,}39 & 2{,}50 & 2{,}78 & 1{,}30 \\
2{,}53 & 2{,}50 & 1{,}19 & 1{,}51 \\
0{,}50 & 0{,}41 & 1{,}51 & 0{,}00 \\
0{,}00 & 0{,}49 & 1{,}19 & 1{,}71 \\
0{,}39 & 0{,}49 & 1{,}30 & 1{,}46 \\
2{,}53 & 2{,}38 & 1{,}30 & 0{,}30 \\
0{,}39 & 2{,}35 & 2{,}78 & 1{,}71 \\
0{,}00 & 0{,}49 & 0{,}00 & 1{,}71 \\
2{,}33 & 2{,}38 & 1{,}19 & 1{,}51 \\
0{,}42 & 0{,}49 & 1{,}51 & 1{,}46 \\
2{,}35 & 2{,}35 & 3{,}03 & 1{,}30 \\
2{,}40 & 2{,}38 & 1{,}51 & 1{,}19 \\
2{,}53 & 0{,}49 & 2{,}63 & 0{,}30 \\
2{,}40 & 2{,}35 & 2{,}78 & 1{,}30
\end{bmatrix}$$

The next step is to determine the distance for each alternative using equation (10) for the positive ideal solution and equation (11) for the negative ideal solution. The results of these calculations are shown in Table 5.

Table 5. The distance for each alternative.

d_i^+	Result	d_i^+	Result	d_i^-	Result	d_i^-	Result
d_1^+	7,76	d_{11}^+	3,75	d_1^-	2,43	d_{11}^-	6,51
d_2^+	2,82	d_{12}^+	3,19	d_2^-	7,86	d_{12}^-	7,23
d_3^+	7,93	d_{13}^+	7,59	d_3^-	2,18	d_{13}^-	2,20
d_4^+	2,15	d_{14}^+	3,53	d_4^-	8,82	d_{14}^-	7,42
d_5^+	7,98	d_{15}^+	6,15	d_5^-	1,91	d_{15}^-	3,88
d_6^+	3,36	d_{16}^+	1,84	d_6^-	6,97	d_{16}^-	9,03
d_7^+	2,35	d_{17}^+	3,31	d_7^-	7,73	d_{17}^-	7,49
d_8^+	7,37	d_{18}^+	4,26	d_8^-	2,43	d_{18}^-	5,95
d_9^+	6,61	d_{19}^+	2,16	d_9^-	3,39	d_{19}^-	8,83
d_{10}^+	6,51			d_{10}^-	3,64		

3.1.6. Compute the closeness coefficient CC_i for each alternative using equations (12). The result is shown in Table 6.

Table 6. The results.

CC_i	Result	CC_i	Result	CC_i	Result	CC_i	Result
CC_1	0,24	CC_6	0,68	CC_{11}	0,63	CC_{16}	0,83
CC_2	0,74	CC_7	0,77	CC_{12}	0,69	CC_{17}	0,69
CC_3	0,22	CC_8	0,25	CC_{13}	0,22	CC_{18}	0,58
CC_4	0,80	CC_9	0,34	CC_{14}	0,68	CC_{19}	0,80
CC_5	0,19	CC_{10}	0,36	CC_{15}	0,39		

3.1.7. Rank the alternatives. The final ranking is shown in Table 7.

Table 7. The final ranking.

Ranking	Code	Result	Ranking	Kode	Result
1	A16	0,83	**11**	A18	0,58
2	A4	0,80	**12**	A15	0,39
3	A19	0,80	**13**	A10	0,36
4	A7	0,77	**14**	A9	0,34
5	A2	0,74	**15**	A8	0,25
6	A12	0,69	**16**	A1	0,24
7	A17	0,69	**17**	A3	0,22
8	A6	0,68	**18**	A13	0,22
9	A14	0,68	**19**	A5	0,19
10	A11	0,63			

3.2. Result

Based on vector in 3.1.3, the business owner's age criteria are considered Very Important (VI) by two assessors, and one assessor considers it important (I). That assessment is reflected in the result of equation (4), where the business owner's age has the highest value among other criteria. The business income per month is the criterion that has the second-highest weight value. Meanwhile, the duration of the business and the quality of the business plan have the same weight value.

Based on the analysis of each criterion, the business owner's age and business income per month is the criterion that affected the result the most. Those two criteria are also the criteria with the highest weight. In addition, between the duration of the business and the quality of business plan criteria which have the same value, the duration of the business criteria slightly influences the result than the other one. The business' duration has a significant difference in value, which is also reflected in the final result.

This research uses the data from the beginner UMKM business capital fund submission in 2019, so the data already has the actual results. Out of 19 candidates, six business owners were selected to get the funds. The candidates that receive the funds are A2, A4, A6, A7, A11, and A16. Those six candidates are ranked in the top ten in manual calculations using Fuzzy TOPSIS. Candidates A16 and A4 ranked first and second, while candidates A7 and A2 ranked fourth and fifth. Two other candidates, which are A6 and A11, took ninth and tenth positions. The two results are different because of the two different methods used by Diskopum and this study. Another factor is the difference in the assessor's preference for the existing data. Apart from the differences, the ranking results obtained using the fuzzy TOPSIS methods are insignificantly different from the actual results. The six candidates who received business funding are ranked in the top ten using the fuzzy TOPSIS method. That is enough to prove that the fuzzy TOPSIS method can determine the ranking of the business capital fund as an alternative method.

4. Conclusion

There are several differences with various factors between the actual result and using fuzzy TOPSIS method. Apart from the differences, the ranking results obtained using the fuzzy TOPSIS method are insignificantly different from the actual results. The six candidates who received business funding are ranked in the top ten using the fuzzy TOPSIS method. From that result, we can conclude that the fuzzy TOPSIS method can be applied in determining the ranking of business capital funds for beginner UMKM as an alternative method. This study could have more precise results by adding the number of assessors and criteria to be more objective. The fuzzy TOPSIS method can also be used in other cases regarding funding from the government in other fields.

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