Comparative analysis of fuzzy database Tahani model and Fuzzy Multi-Attribute Decision Making TOPSIS method in cotton product for determination recommendations in textile industry (Case study: PT. Pandatex)

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Abstract. PT. Pandatex is a company engaged in the textile industry with raw materials derived from fibers. Product selection based on supplier offers makes it difficult for companies to make choices that match the quality classification and production needs. This research was made by comparing the fuzzy Tahani method and the FMADM TOPSIS method with the same parameters like fiber strength, fiber length, micronaire, price, quantity, and shipment. The fuzzy Tahani method is used to find the value of the degree of membership through the fuzzification process and the value of fire strength. Meanwhile, the FMADM TOPSIS method is used to find the best alternative from alternatives that have the shortest distance from the positive ideal solution, and have the longest distance from the negative ideal solution. The results of this study were conducted with case trials. The fuzzy Tahani method produces 4 recommendations and the FMADM TOPSIS method results in a ranking of all cotton products. From the final results of the two methods used, the calculation of the fuzzy Tahani method is more accurate with accuracy in calculating the value of fire strength.

1. Introduction

The textile industry is a labor-intensive industry where in terms of labor, the development or addition of industrial capacity can easily be accommodated by an abundance of workers with more competitive wages. The ability of the textile industry to be increasingly competitive, both in the domestic and global markets, can be seen in the growth rate of the textile industry throughout 2018 which was recorded at 8.73 percent or able to exceed the national economic growth of 5.17 percent [1].

PT. Pandatex is a company engaged in the textile industry with raw materials derived from fibers. Fabric is the product of the company. One of the processes of processing materials in fabrics that must be considered in the selection of the right cotton product as the main raw material, so as not to hamper the production process at the company. The increase in fabric production was offset by the large supply of raw materials with various kinds of product submissions offered by suppliers. Selection of products based on offers supplier makes it a little difficult for the company to make choices that match the quality classification and production needs because the product selection process is initially determined only
based on price and the quantity that are not taken into account so that the results obtained are less than optimal.

The MCDM (Multi-Criteria Decision Making) method is a method for selecting the best alternative from several mutually exclusive alternatives based on general performance in various criteria determined by decision-makers [2]. However, this method has a weakness, it is inefficient for resolving incorrect, uncertain, and unclear data. Usually, this method assumes that the final decision on an exclusive alternative is expressed in real numbers so that the ranking stage is less representative of certain problems and problem-solving is only centered on the aggregation stage [3]. Fuzzy AHP (Analytic Hierarchy Process) is combined with an approach AHP concept. Fuzzy AHP closes the weaknesses that exist in AHP, namely problems with criteria that have more subjective characteristics. The uncertainty of numbers is represented by an order of scale [4]. However, the disadvantage of fuzzy AHP is the need for additional information, namely optimistic values and pessimistic values [5].

Along with technological developments, there is an idea that can define the concept of relations fuzzy in a Database Management System (DBMS) by using membership degrees. This idea was put forward by Tahani in 1977. On the fuzzy Tahani uses set fuzzy theory to obtain information in queries [6]. The Method Fuzzy Multi-Attribute Decision Making (FMADM) is a development of the Multi-Attribute Decision Making (MADM). In decision making, if a problem cannot be presented accurately into a crisp value, the application of logic Fuzzy can be a solution. The application of logic fuzzy in the MADM method is better known as Fuzzy Multi-Attribute Decision Making [7].

In this study, a comparative analysis was carried out by fuzzy Tahani and the FMADM TOPSIS method. The parameter to be used are fuzzy criteria including fiber strength, fiber length, fiber fineness or micronaire, price, quantity, and shipment. The purpose of this study was to determine the most appropriate method to use in determining cotton product recommendations.

2. Literature Review

2.1. Related work

These are the following related research to comparative analysis and determination of recommendations using the fuzzy database Tahani model or the fuzzy MADM TOPSIS. First related research is about comparison analysis of poverty assistance recipients with WP and TOPSIS method [8]. The results of this study include the main factors that influence the calculation results. In addition, the use these method is part of MADM which aims to rank the alternatives that are compared in the form of the resulting total preference value. Another research related to a comparative analysis of methods is the comparison analysis of TOPSIS and SAW methods in determining recipients of assistant community development [9]. The results of this study are being able to solve cases with the TOPSIS and SAW methods with several conditions that have been determined by sensitivity testing that the most optimal method is SAW, with a change in SAW value of 14.65% while TOPSIS is 4.02%.

Comparison of AHP and fuzzy Mamdani for decision support system for house selection in Cepu area was introduced by Widyassari and Yuwono. The comparison between AHP and fuzzy Mamdani with the case of house selection is 0.90298. The accuracy level of AHP is better than fuzzy Mamdani in the case of house selection with MSE of 0.048538 [10]. Research conducted by Astari and Komarudin regarding the selection of the best employees uses the criteria of knowledge, expertise, personality, work discipline, and loyalty [11]. The results of this study are using Tahani fuzzy logic, the assessment is more accurate and reduces subjectivity in selecting the best employees in the decision support system research at PT. Culture Royale. Further research was introduced by Rochman in his research which examines recommendations for purchasing auction items using the criteria of price, quality, quantity, bidder interest, and claims for data analysis using the Tahani model fuzzy database method. The results from this study are the application can assist companies in remodeling the choice by showing that the decision support system can work properly with a 70% [12].

2.2. Fuzzy database Tahani model
The Fuzzy database Tahani model still uses standard relations, but the model uses a set fuzzy theory to get information on its queries. Therefore, the initial data that is processed is data that has a value crisp (certain or clear existence), and when searching for cryptic data, the process is called a process fuzzy query through a fuzzy database the Tahani model. The idea of the fuzzy database Tahani model is to use membership degrees to define the concept of relations fuzzy in a database system [13].

2.3. Fuzzy Multi-Attribute Decision Making TOPSIS method
The MADM method refers to making decisions based on the selection of several options. In decision making, if a problem cannot be presented accurately into a value crisp, the application of fuzzy logic can be a solution, which is better known as Fuzzy MADM.

The TOPSIS method uses the principle that the chosen alternative must have the closest distance from the positive ideal solution and the farthest distance from the negative ideal solution. This concept is widely used in several MADM models to solve decision problems because the concept is simple and easy to understand, the computation is efficient, can measure the performance of decision alternatives in a simple mathematical form [7].

2.4. Textile
The industry is a business to process semi-finished goods or raw materials into finished goods that have added value for profit. Meanwhile, the textile is material from fibers that are processed in the form of cloth or yarn as a material for making clothing or other products [14]. Textiles are defined as goods or objects whose raw materials come from fibers (cotton, polyester, rayon) by spinning them into threads and then weaving them, or knitting them into fabrics after finishing (refinement) using raw materials, textile products [15]. The textile industry which uses cotton fiber as raw material, the quality of the raw material needs to be known in order to predict the quality of production (yarn or textile). The quality of cotton fiber is stated based on the staple length, grade, and character determined by a cotton classer well-trained. Characteristics of cotton fiber are influenced by strength, smoothness, maturity, and stretchability [16][17].

3. Research Method
The stages for designing the fuzzy database Tahani model and fuzzy MADM TOPSIS method to solving the problem by choosing the best solution are as follows:

3.1. Fuzzy database Tahani model
In the fuzzy Tahani method, there are parameters and fuzzy sets, each fuzzy set has a domain. There are 6 parameters used in this study, namely: price, fiber length, fiber strength, micronaire, quantity, and shipment. The stages for using the fuzzy Tahani method can be seen in Figure 1.

3.1.1. Define the parameters and member function. These following are the parameters and membership functions used by the fuzzy database Tahani model:
1. Price parameters
   The price parameters consist of 3 fuzzy sets, namely low, normal, and high. Low and high sets use a linear function approach. While in the normal set uses a triangular membership function. The membership function in the price parameter can be formulated as in the equation (1).
\[ \mu_{\text{LowPrice}}[x_1] = \begin{cases} 1; & x_1 \leq 60 \\ \frac{75 - x_1}{(75 - 60)}; & 60 \leq x_1 \leq 75 \\ 0; & x_1 \geq 75 \end{cases} \]

\[ \mu_{\text{NormalPrice}}[x_1] = \begin{cases} 0; & x_1 \leq 70 \text{ or } x_1 \geq 90 \\ \frac{x_1 - 70}{(80 - 70)}; & 70 \leq x_1 \leq 80 \\ \frac{90 - x_1}{(90 - 80)}; & 80 \leq x_1 \leq 90 \end{cases} \]

\[ \mu_{\text{HighPrice}}[x_1] = \begin{cases} 0; & x_1 \leq 65 \\ \frac{x_1 - 85}{(100 - 85)}; & 85 \leq x_1 \leq 100 \end{cases} \]

2. Fiber length parameters
The fiber length parameters consists of 3 fuzzy sets, namely short, medium, and long. Short and long sets use a linear function approach. While in the medium set uses a triangular membership function. The membership function in the fiber length parameter can be formulated as in the equation (2).

\[ \mu_{\text{FiberLengthSHORT}}[x_2] = \begin{cases} 1; & x_2 \leq 0,8 \\ \frac{1,1 - x_2}{(1,1 - 0,8)}; & 0,8 \leq x_2 \leq 1,1 \\ 0; & x_2 \geq 1,1 \end{cases} \]

\[ \mu_{\text{FiberLengthMEDIUM}}[x_2] = \begin{cases} 0; & x_2 \leq 1 \text{ or } x_2 \geq 1,1 \\ \frac{x_2 - 1}{(1,12 - 1)}; & 1 \leq x_2 \leq 1,12 \\ \frac{1,2 - x_2}{(1,23 - 1,12)}; & 1,12 \leq x_2 \leq 1,23 \\ 0; & x_2 \geq 1,13 \end{cases} \]

\[ \mu_{\text{FiberLengthLONG}}[x_2] = \begin{cases} 0; & x_2 \leq 1,13 \\ \frac{x_2 - 1,13}{(1,36 - 1,13)}; & 1,13 \leq x_2 \leq 1,36 \\ 1; & x_2 \geq 1,36 \end{cases} \]

3. Fiber strength parameters
The fiber strength parameters consists of 3 fuzzy sets, namely intermediate, average, and strong. Intermediate and strong sets use a linear membership function. While in the average set uses a triangular membership function. The membership function in the fiber strength parameter can be formulated as in the equation (3).

\[ \mu_{\text{FiberStrengthINTERMEDIATE}}[x_3] = \begin{cases} 1; & x_3 \leq 24 \\ \frac{26 - x_3}{(26 - 24)}; & 24 \leq x_3 \leq 26 \\ 0; & x_3 \geq 26 \end{cases} \]

\[ \mu_{\text{FiberStrengthAVERAGE}}[x_3] = \begin{cases} 0; & x_3 \leq 25 \text{ or } x_3 \geq 29 \\ \frac{x_3 - 25}{(27 - 25)}; & 25 \leq x_3 \leq 27 \\ \frac{29 - x_3}{(29 - 27)}; & 27 \leq x_3 \leq 29 \end{cases} \]

\[ \mu_{\text{FiberStrengthSTRONG}}[x_3] = \begin{cases} 0; & x_3 \leq 28 \\ \frac{x_3 - 28}{(30 - 28)}; & 28 \leq x_3 \leq 30 \\ 1; & x_3 \geq 30 \end{cases} \]
4. Micronaire parameters
The micronaire parameters consists of 3 fuzzy sets, namely fine, medium, and coarse. Fine and coarse sets use a linear membership function. While in the medium set uses a triangular membership function. The membership function in the micronaire parameter can be formulated as in the equation (4).

\[
\mu_{\text{MicFINE}}[x_4] = \begin{cases} 
1; & x_4 \leq 3 \\
\frac{(4 - x_4)}{(4 - 3)}; & 3 \leq x_4 \leq 4 \\
0; & x_4 \geq 4
\end{cases}
\]

\[
\mu_{\text{MicMEDIUM}}[x_4] = \begin{cases} 
\frac{(x_4 - 3.9)}{(4.45 - 3.9)}; & 3.9 \leq x_4 \leq 4.45 \\
\frac{(5 - x_4)}{(5 - 4.45)}; & 4.45 \leq x_4 \leq 5 \\
0; & x_4 \geq 4.9
\end{cases}
\]

\[
\mu_{\text{MicCOARSE}}[x_4] = \begin{cases} 
0; & x_4 \leq 4.9 \\
\frac{(x_4 - 4.9)}{(6 - 4.9)}; & 4.9 \leq x_4 \leq 6 \\
1; & x_4 \geq 6
\end{cases}
\]

5. Quantity parameters
The quantity parameters consists of 3 fuzzy sets, namely a few, normal, and a lot of. A few and a lot of sets use a linear membership function. While in the normal set uses a triangular membership function. The membership function in the quantity parameter can be formulated as in the equation (5).

\[
\mu_{\text{QuantityAFew}}[x_5] = \begin{cases} 
1; & x_5 \leq 50 \\
\frac{(100 - x_5)}{(100 - 50)}; & 50 \leq x_5 \leq 100 \\
0; & x_5 \geq 100
\end{cases}
\]

\[
\mu_{\text{QuantityNormal}}[x_5] = \begin{cases} 
\frac{(x_5 - 30)}{(200 - 100)}; & 30 \leq x_5 \leq 65 \\
\frac{(300 - x_5)}{(300 - 200)}; & 65 \leq x_5 \leq 100 \\
0; & x_5 \geq 100
\end{cases}
\]

\[
\mu_{\text{QuantityALotOf}}[x_5] = \begin{cases} 
0; & x_5 \leq 250 \\
\frac{(x_5 - 250)}{(500 - 250)}; & 250 \leq x_5 \leq 500 \\
1; & x_5 \geq 500
\end{cases}
\]

6. Shipment parameters
The shipment parameters consists of 3 fuzzy sets, namely fast, normal, and slow. A few and a lot of sets use a linear membership function. While in the normal set uses a triangular membership function. The membership function in the shipment parameter can be formulated as in the equation (6).

\[
\mu_{\text{ShipmentFast}}[x_6] = \begin{cases} 
1; & x_6 \leq 6 \\
\frac{(40 - x_6)}{(40 - 6)}; & 6 \leq x_6 \leq 40 \\
0; & x_6 \geq 40
\end{cases}
\]

\[
\mu_{\text{ShipmentNORMAL}}[x_6] = \begin{cases} 
\frac{(x_6 - 30)}{(65 - 30)}; & 30 \leq x_6 \leq 65 \\
\frac{(100 - x_6)}{(100 - 65)}; & 65 \leq x_6 \leq 100
\end{cases}
\]
\[ \mu_{\text{ShipmenSlow}}[x_6] = \begin{cases} 
0; & x_6 \leq 90 \\
\frac{(x_6 - 90)}{90}; & 90 \leq x_6 \leq 150 \\
1; & x_6 \geq 150 
\end{cases} \]

### 3.1.2. Fuzzification
Fuzzification is the first phase of fuzzy calculation, which is the process of converting firm values to values fuzzy. The strict value referred to in this case is the parameter value of cotton products. The value of the cotton product parameter is used as a value fuzzy which will be calculated as the value of its membership degree to the set fuzzy. The calculation is performed using the membership function expression fuzzy contained in each parameter. The membership function used the linear membership function and the triangular membership function. These are the following of cotton product data used for fuzzification calculations, as shown in Table 1.

| ID | Price | Fiber length | Microaire | Fiber Strength | Quantity | Shipment |
|----|-------|--------------|-----------|---------------|----------|----------|
| 46 | 72    | 1.06         | 4.9       | 26            | 325      | 165      |
| 57 | 75.69 | 1.1          | 4.9       | 27            | 500      | 134      |
| 77 | 75.37 | 1.17         | 4.9       | 28            | 100      | 43       |
| 129| 74.57 | 1.17         | 44.6      | 30.5          | 500      | 74       |
| ...| ...   | ...          | ...       | ...           | ...      | ...      |
| 402| 70.75 | 1.1          | 4.9       | 28            | 110      | 45       |

### 3.1.3. Query fuzzification
Query fuzzification by taking parameter data fuzzy including price, fiber length, fiber strength, micronaire, quantity, and shipment to perform criteria selection on cotton products according to input user. The concept of relation fuzzy in a DBMS uses the degree of membership which is calculated based on the respective membership functions [18].

### 3.1.4. Zadeh basic operator for fuzzy set operations
In this study, the operator used is the AND operator to combine variables. The AND operator is obtained by taking the smallest membership value between elements in the relevant set using the min function. The recommended cotton products are those that have a recommendation of \(0 < \text{fire strength} \leq 1\). Cotton products that have a fire strength equal to 0 are not recommended. The higher the value, fire strength the greater the chance for the cotton product to be recommended.

### 3.2. Fuzzy Multi-Attribute Decision Making TOPSIS method
The fuzzy MADM TOPSIS method is used to rank by the following stages can be seen in Figure 2.

**Figure 2.** Stages of the fuzzy MADM TOPSIS method

#### 3.2.1. Determining the criteria
The criteria used are as follows: price (C1), fiber length (C2), fiber strength (C3), micronaire (C4), quantity (C5), shipment (C6). These criteria are then determined by the weights. This weight is in the form of a fuzzy number which is converted to a crisp number. The crisp
number that is closer to number 1, then the higher of the dependency level, while the crisp number that is closer to the number 0, then the lower of the dependency level.

Price, quantity, and shipment criteria each consist of three fuzzy numbers, namely: low (R), normal (N), and high (T) for the price criteria. Furthermore, for the quantity criteria, namely: little (S), normal (N), and a lot (B). Then for the shipment criteria, namely: fast (C), normal (N), and long (L).

The criteria for fiber length, fiber strength, and micronaire consist of five fuzzy numbers, namely: short (SR), intermediate (I), medium (M), long (L), and very long (VL). Furthermore, for fiber strength criteria, namely: weak (W), intermediate (I), average (AVG), strong (ST), and very strong (VST). Then for the micronaire criteria, namely: very fine (VF), fine (F), average (AVG), coarse (C), and very coarse (VC).

From each of these weights, a variable is created which will be converted into a fuzzy number with a formula as in equation (7).

\[ \text{var}_n = \frac{\text{var}_{n-1}}{m-n} \]  \hspace{1cm} (7)

with \( n = 0, 1, 2, \ldots, n \); and \( m = 1, 2, \ldots, m \).

As in equation (7), \( \text{var}_n \) is the \( n \)-th variable and \( m \) is the number of variables.

### Table 2. Variables and weight values on the criteria C1, C5, and C6

| Fuzzy number | Crisp Value |
|--------------|-------------|
| Low (R), A few (S), Fast (C) | \( V_0 / (3-1) = 0/2 = 0 \) |
| Normal (N) | \( V_1 / (3-1) = 1/2 = 0.5 \) |
| High (T), A lot of (B), Slow (L) | \( V_2 / (3-1) = 2/2 = 1 \) |

### Table 3. Variables and weight values on the criteria C2, C3, and C4

| Fuzzy number | Crisp Value |
|--------------|-------------|
| Short (SR), Weak (W), Very Fine (VF) | \( V_0 / (5-1) = 0/4 = 0 \) |
| Intermediate (I), Fine (F) | \( V_1 / (5-1) = 1/4 = 0.25 \) |
| Medium (M), Average (AVG) | \( V_2 / (5-1) = 2/4 = 0.5 \) |
| Long (L), Strong (ST), Coarse | \( V_3 / (5-1) = 3/4 = 0.75 \) |
| Very Long (VL), Very Strong (VS), Very Coarse (VC) | \( V_4 / (5-1) = 4/4 = 1 \) |

### 3.2.2. Building normalized decision matrix.

The TOPSIS normalized decision matrix requires a performance rating of each alternative \( A_i \) on each normalized weight of the \( C_j \) criterion. These are the following of the process of normalizing the attribute values to form a normalized matrix (R):

\[ r_{ij} = \frac{x_{ij}}{\left( \sum_{i=1}^{m} x_{ij}^2 \right)^{1/2}} \]  \hspace{1cm} (8)

with \( i = 1, 2, \ldots, m \); and \( j = 1, 2, \ldots, n \).

As in equation (8), \( r_{ij} \) is the element of the normalized decision matrix and \( x_{ij} \) is the \( i \)-th alternative performance rating for the \( j \)-th attribute.

### 3.2.3. Building a weighted normalized decision matrix.

These are the following process of multiplying the weight with the value of each attribute to form a matrix (y) which is then used to determine the ideal positive solution \( A^+ \) and the ideal negative solution \( A^- \):
\[ y = \begin{bmatrix} y_{11} & y_{12} & \ldots & y_{1j} \\ y_{21} & y_{22} & \ldots & y_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ y_{il} & y_{i2} & \ldots & y_{ij} \end{bmatrix} \]  

(9)

for \( y_{ij} = w_i r_{ij} \); with \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \).

As in equation (9), \( y_{ij} \) is the element of the weighted normalized decision matrix, while \( w_i \) is the weight of the \( j \)-th criterion and \( r_{ij} \) is the element of the normalized decision matrix.

### 3.2.4. Determine the ideal solutions of positive and negative value.

The positive ideal solution is denoted by the \( A^+ \) symbol and the negative ideal solution is denoted by the symbol \( A^- \). The positive ideal solution is defined as the sum of all the best scores that can be achieved for each attribute, while the negative ideal solution consists of all the worst scores achieved for each attribute.

\[
A^+ = (y_1^+, y_2^+, \ldots, y_n^+),
\]

(10)

\[
A^- = (y_1^-, y_2^-, \ldots, y_n^-),
\]

(11)

\[
y_{j}^+ = \max_{i} y_{ij} \text{; if } j \text{ is an attribute of benefit}
\]

(12)

\[
y_{j}^- = \min_{i} y_{ij} \text{; if } j \text{ is an attribute of cost}
\]

(13)

with \( j = 1, 2, \ldots, n \).

### 3.2.5. Calculate the distance from an alternative to positive ideal solution and negative ideal solution.

The distance between the value of each alternative with the positive ideal solution matrix and the negative ideal solution matrix. The distance between the alternative \( A_i \) and the positive ideal solution is defined as:

\[
D_i^+ = \left( \sum_{j=1}^{n} (y_{ij}^+ - y_{ij})^2 \right)^{1/2}
\]

(14)

with \( i = 1, 2, \ldots, m \).

The distance between the alternative \( A_i \) and the negative ideal solution is defined as:

\[
D_i^- = \left( \sum_{j=1}^{n} (y_{ij} - y_{ij}^-)^2 \right)^{1/2}
\]

(15)

with \( i = 1, 2, \ldots, m \).

### 3.2.6. Calculate the preference value for each alternative.

The preference value for each alternative (\( V_i \)) is given as:

\[
V_i = \frac{D_i^-}{D_i^+ + D_i^-}
\]

(16)

with \( i = 1, 2, \ldots, m \). A larger \( V_i \) value indicates that the alternative \( A_i \) is prioritized.

### 3.2.7. Alternative ranking.

Alternatives can be ranked according to the order of \( V_i \) from the largest to the smallest. Therefore, the best alternative is nearest to the ideal positive solution and inmost away from the negative ideal solution. The alternative with the enormous \( V_i \) is the best solution.

### 4. Results and Analysis

#### 4.1. Trial case with fuzzy database Tahani model

The cotton product desired by the user has the grade/type LM (Low Middling), SM (Strict Low Middling), and MID (Middling). The selection of cotton product data on the input grade/type according to all cotton product data (421 data) has been selected as many as 270 cotton product data with grade/type LM, SM, and MID. This trial case is using the AND operator.
After the grade/type of the selected cotton product has been selected, then choose the criteria for cotton products with low prices, large quantities, strong fiber strength, medium fiber length, and coarse micronaire (coarse) as well as normal delivery times. Then calculate the value of the degree of membership in each selected cotton product data. These are the following calculation of the membership value from cotton product data with id 46.

Calculation of price parameters using equation (1). The membership value for the price parameter is = 0.2. Then for the calculation of the fiber strength parameters using the equation (3). The membership value for the fiber strength parameter is = 0. Then for the calculation of the quantity parameters using the equation (5). The membership value for the quantity parameter is = 0.3. Then for the calculation of the shipment parameters using the equation (6). The membership value for the shipment parameter is = 0.2. Then for the calculation of the micronaire parameters using the equation (4). The membership value for the micronaire parameter is = 0.2. Then for the calculation of the fiber length parameters using the equation (2). The membership value for the fiber length parameter is = 0.5217.

The calculation of the recommendation value by taking the smallest membership value between elements in the relevant set uses the min function. The data with id 46 has value 0 and data with id 129 has 0.029 according to the smallest membership value.

If the final result of the recommendation value is 0 then it is not recommended. Then the value of fire strength is ranked from highest to lowest. These are the following final result of product recommendations, as shown in Table 4.

| ID  | Name                   | Grade | Value of fire strength |
|-----|------------------------|-------|------------------------|
| 114 | USA MOT RECAPS         | SLM   | 0.177                  |
| 119 | USA SOUTH TEXAS RECAPS | MID   | 0.1753                 |
| 279 | USA M/E RECAPS         | MID   | 0.1                    |
| 129 | USA M/E RECAPS         | LM    | 0.029                  |

4.2. Trial case with fuzzy Multi-Attribute Decision Making TOPSIS method

These are the following stages for the trial case carried out with the fuzzy Multi-Attribute Decision Making TOPSIS method:

The decision matrix is calculated based on the alternative value for each criteria. These are the following calculation result of the decision matrix on cotton products, as shown in Table 5.

| ID | Price | Fiber length | Fiber strength | Micronaire | Quantity | Shipment |
|----|-------|--------------|----------------|------------|----------|----------|
| 46 | 0,5   | 0,5          | 0,5            | 0,75       | 1        | 1        |
| 57 | 0,5   | 0,5          | 0,5            | 0,75       | 1        | 1        |
| 77 | 0,5   | 0,75         | 0,5            | 0,75       | 0,5      | 0,5      |
| 129| 0,5   | 0,75         | 1              | 1          | 1        | 0,5      |
| ...| ...   | ...          | ...            | ...        | ...      | ...      |
| 402| 0,5   | 0,5          | 0,5            | 0,75       | 0,5      | 0,5      |

Determine a preference weights by assigning properties to each criterion. Attribute consists of benefits and costs. C1=1 (benefit), C2=0,75 (benefit), C3=0,5 (benefit), C4=0,5 (benefit), C5=1 (benefit), and C6=0,25 (cost).

Build a normalized matrix and produce a normalized matrix R. Here is a calculation to determine the normalized matrix in alternative 1 using equation (8):
\[ r_{11} = \frac{0.5}{(x_1^2 + x_2^2 + x_3^2 + x_4^2 + \ldots + x_{270}^2)^{1/2}} = \frac{0.5}{8.3367} = 0.05998 \]

Build a weighted normalized matrix. These are the following calculation to determine a weighted normalized matrix in alternative 1 using equation (8): 
\[ y_{11} = w_1 r_{11} = 1(0.05998) = 0.05998 \]

Determine the positive ideal solution and the negative ideal solution. These are the following results of calculating the positive ideal solution using equations (10), (11), (12), and (13). Positive ideal solution for C1=0.11995, C2=0.05478, C3=0.03987, C4=0.03754, C5=0.07625, and C6=0.01821. While negative ideal solution for C1=0, C2=0.01826, C3=0.01994, C4=0, C5=0, and C6=0.0091.

Table 6. Ranking

| No | ID | Name | Preference value |
|----|----|------|-----------------|
| 1  | 35 | 19/20 SJV ACALA SAW GIN | 0.92019 |
| 2  | 37 | 19/20 SJV ROLLER GIN    | 0.92019 |
| 3  | 38 | 19/20 SJV ROLLER GIN    | 0.92019 |
| 4  | 210 | USA M/E 2019/20       | 0.87475 |
| 5  | 293 | USA SOUTH TEXAS RECAPS | 0.79394 |
| ... | ... | ... | ... |
| 270 | 92 | USA RECAPS M/E 2018/19 CROP | 0.38888 |

Calculate the positive ideal distance and the negative ideal distance, which is the distance between the value of each alternative with the positive and negative ideal solution matrix. These are the following of calculation to determine the positive and negative ideal distances in alternative 1 using equations (14) and (15):
\[ D_1^+=\left(0.11995-0.05998\right)^2+(0.05478-0.03652)^2+\ldots+(0.01821-0.01821)^2\right)^{1/2} = 0.06645 \]
\[ D_1^-\left((0.05998-0)^2+(0.03652-0.01826)^2+\ldots+(0.01821-0.00910)^2\right)^{1/2} = 0.10305 \]

Calculate the preference value for each alternative using equation (16).
\[ V_1^+ = \frac{0.10305}{0.10305+0.06645} = 0.60796 \]

Display the alternative ranking of the product, by the highest to lowest preference values. These are the following final result of the cotton product ranking, as shown in Table 6.

Table 7. Comparison results

| ID | Fuzzy Tahani | FMADM TOPSIS |
|----|--------------|---------------|
|    | Fire Strength| Rank          | Preference value| Rank |
| 46 | 0            | -             | 0.60796         | 94   |
| 57 | 0            | -             | 0.60796         | 95   |
| 77 | 0            | -             | 0.53055         | 193  |
| 129| 0.029        | 4             | 0.64873         | 9    |
| 114| 0.177        | 1             | 0.62915         | 64   |
| 119| 0.1753       | 2             | 0.62322         | 80   |
| 279| 0.1          | 3             | 0.62322         | 82   |
| ...| ...           | ...           | ...             | ...  |
| 402| 0            | -             | 0.50462         | 257  |

4.3. Comparison results from the fuzzy Tahani method and the fuzzy MADM TOPSIS method
In the Tahani fuzzy method, alternatives with id 46, 57, and 77 have a fire strength value of 0, so the alternative is not recommended. Meanwhile, the alternative fuzzy MADM TOPSIS method with id 46, 57, and 77 has a preference value of 0.60796; 0.60796; and 0.53055 and the three of them are ranked in the 94th, 95th, and 193th places (Table 7). The final results obtained from the calculations by these two methods can be concluded that there are differences. The two methods used in this study can play a role in determining the recommendation for cotton products.

5. Conclusion

In this study, it can be concluded that the fuzzy database method Tahani model and the fuzzy MADM TOPSIS method can be used in completing the selection of several alternatives based on several predetermined criteria. Comparison method of fuzzy Tahani and fuzzy MADM Topsis is obtained from the results of fire strength values and preference values.

The results of the calculation on fuzzy Tahani carried out with a trial case that resulted in 4 recommendations for cotton products, namely USA MOT Recaps with a value of 0.177, USA South Texas Recaps with a value of 0.1753, USA M/E Recaps with a value of 0.0853 and USA M/E Recaps with a value of 0.0286. Where as for the results of the calculation on fuzzy MADM TOPSIS method produces a ranking for all recommended cotton products starting from 19/20 SJV Acala Saw Gin, 19/20 SJV Roller Gin, 19/20 SJV Roller Gin with the same value, 0.92019, USA M/E 2019/20 with a value of 0.87475, USA South Texas Recaps with a value of 0.79394 and so on. It can be seen from the final results of the two methods used, the calculation of method is fuzzy database Tahani model more accurate with accuracy in calculating the value of fire strength and the parameters used in choosing this cotton product are relative and have multiple meanings.

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