Comparison of AHP-TOPSIS Hybrid Methods, WP and SAW for Multi-Attribute Decision-Making to Select The Best Electrical Expert

Wiwien Hadikurniawati¹, Edy Winarno¹, Taufik Dwi Cahyono² and Dahlan Abdullah³

¹Faculty of Information Technology, Universitas Stikubank, Semarang, Indonesia
²Department of Electrical Engineering, Faculty of Engineering, Universitas Semarang, Semarang, Indonesia.
³Department of Informatics, Universitas Malikussaleh, Aceh Utara, Indonesia

*wiwien@edu.unisbank.ac.id

Abstract. This study examined the three most widely used Multi-Attribute Decision-Making (MADM) methods in alternative decision making of Electrical Expert (EE) selection: hybrid AHP (Analytic Hierarchy Process) and TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution) methods, Weight Product (WP), Simple Additive Weighting (SAW). The advantages and limitations of each parameter are identified to assist decision makers in selecting the right MADM technique. The essence of MADM is to determine the weighting value for each parameter followed by the rank which will select the given alternative. The difference in the ranking order of this method is due to the effects of alternative values, weighting criteria, and calculation methods. AHP is a MADM method that has consistency in giving weighting to its parameters while TOPSIS, SAW and WP methods have no consistency. The results of the decision-making process using WP and SAW methods show similar results for alternative rankings. The WP and SAW methods have the same core process of calculating the weighted average parameters. The use of the AHP-TOPSIS hybrid method in the decision-making process produces the same top ranking as any other method. The AHP-TOPSIS hybrid method has a consistency in the weighting process on its parameters.

1. Introduction

Multi-attribute decision-making (MADM) is a branch of the operations research model that handles decision issues with a number of decision parameters. Multi-attribute decision making refers to making decision preferences, such as evaluation, prioritization and selection of available alternatives. The development of decision making increases, the decision maker is possible more than one. The sociocultural differences of each decision maker influence decision makers to give their preferences in unequal formats, whether preferences for the degree of importance of each parameter, as well as the preferences of alternative match rates and parameters. Multi attribute Decision Making (MADM) is used to solve the problem of choosing the optimal alternative from several related alternatives in its attributes. [1] stated that MADM is an important research topic in decision-making theory. [2] stated that decision makers on multi-attribute decision-making methods can pinpoint alternatives appropriately. Decision makers can produce better solutions to complex problems by involving the opinions of some expert [3]. Decision-making consists of several stages. The stages are:
identifying problems, (2) developing alternative designs, (3) evaluating design alternatives through evaluation schemes and (4) choosing the best alternative. Ranking is often used to determine the priority of an activity. Rank is an important sequence of events that have been processed. The sequence can be based on the variable of an event. The MADM technique is a popular technique and is used in many fields of science such as engineering, economics, management, transportation planning, and so forth [4].

[5] states that multi-attribute decision-making aims to reach a decision by choosing the best alternative from some potential candidates, placing the subject to a beneficial or unfavorable parameter or attribute (cost). [6] stated that Multi Attribute Decision Making (MADM) proved to be effective for solving problems and making alternative priorities with multi-criteria variations very much. The MADM problem is expressed in matrix format.

Multi-attribute decision-making aims to reach decisions by selecting the best alternative from several potential candidates, placing alternatives to beneficial or unfavorable parameters. Multi Attribute Decision Making (MADM) proved to be effective for solving problems and making alternative priorities with multi-criteria variations. The MADM problem is expressed in matrix format[7][8]. [7] stated that the theory and method of decision-making is not the same as researchers in the world. [8] proposes a process that can solve consensus-based decision-makers to choose one of two options. This is implemented in the uncertainty assessment plan on decision making using the Analytic Hierarchy Process (AHP) approach. [9] in their research used FMADM with TOPSIS and Weighted Product (WP) methods. They are applied to select the candidates for academic and non-academic scholarships in a university. The data used were crisp and fuzzy data. The results show that TOPSIS and Weighted Product FMADM methods can be used to select the most suitable candidates.

[10] proposed a multi-criteria decision-making approach based on the Model of Preference Model with Ideal Solution (TOPSIS) to extract the regional context and visual topics of an image. [11] used Analytic Network Process (ANP) to select a type of microcontroller for practicing material. [12] in his study discusses multi-criteria decision making that has alternatives in the form of suggestions for students who will choose courses based on students' academic ability to continue higher education. This research uses Elimination et Choix Tranduit La Realite (ELECTRE) method. In the study, [13] it is also explained that SAW method is a popular method for solving MADM problems and WP method is a method that can solve multi-dimensional problems. [14] in their group decision-making research using a fuzzy approach to determine the highest alternative priorities. [15] used linguistic values expressed by triangular fuzzy numbers for their decision-making framework.

The main core of the SAW method is the determination of the weights, so that the SAW algorithm can be updated in the determination of the weight value because it is possible that the decision maker cannot determine the parameter weight.

The competence of human resources in the field of electricity is very important for national development so the government issues Law No. 15 on Electricity. The Government has compiled Government Regulation No. 3/2005 as amendment to Government Regulation No. 10/1999 on the Provision and Utilization of Electricity, stating that "Every technical personnel working in the electricity business shall have a certificate of competence". This regulation is a form of implementation of the Law on Electricity. To obtain a certificate of competence, a construction service expert in electrical field must follow a series of competence tests. The competency test includes the components of knowledge, skill and attitude. Knowledge, skill and attitude components are obtained from several tests, both written test, practice and oral test. Each component has criteria.

This study examined the three most widely used MADM methods in alternative decision making of electrical expert selection: hybrid AHP and TOPSIS method, weight process (WP), simple additive weighting (SAW). The advantages and limitations of each parameter are identified to assist the decision maker in selecting the appropriate MADM technique.

The best alternative choice is applied in decision making issues to determine qualified electrical expert through a competency test. The remainder of this paper is structured as follows. Section 2 describes the work related to our research. Section 3 describes the approach of decision-making.
methods (AHP, TOPSIS, WP and SAW). Section 4 discusses the case studies, analyzes and results of our research. Our conclusions are presented in Section 5.

2. Methods

2.1. Analytic Hierarchy Process (AHP)

This method was developed by a mathematician Thomas L. Saaty. AHP is a functional hierarchy model with the main input of human perception. Complex or unstructured problems are decomposed into sections and then organized into hierarchical forms. AHP has the ability to break multi-attribute problems based on the preference comparison of each element in the hierarchy. AHP is a decision-making tool that describes complex problems in hierarchical structures with different levels of parameters and alternatives. An AHP pairwise comparison matrix is formed and describes the relative contribution of each element to each parameter. An assessment matrix is formed according to the decision maker’s decision. This is used to calculate the priority of the element. Pairwise comparison is measured using scale. The scale proposed by Saaty is described in Table 1.

| Intensity of Importance | Definition | Explanation |
|-------------------------|------------|-------------|
| 1                       | Equal importance | The activities have the same contribution to the objective |
| 2                       | Weak       |                          |
| 3                       | Moderate importance | Judgments strongly favor one activity over another |
| 4                       | Moderate plus |                          |
| 5                       | Strong importance | Experience and judgment strongly favor one activity over another |
| 6                       | Strong plus |                          |
| 7                       | Very strong demonstrated | An activity is favored very strongly over another |
| 8                       | Very, very strong |                          |
| 9                       | Extreme importance | The evidence favoring one activity over another is of the highest possible order of affirmation |

Saaty advised the utilization of the Consistency Index (CI) and the Consistency Ratio (CR) to verify the consistency of the comparison matrix. CI and CR are defined as follows [2]:

\[
CI = \frac{\lambda_{\text{max}} - n}{n - 1}
\]  

(1)

where

- \(\lambda_{\text{max}}\) = maximum eigenvalue
- \(n\) = size of matrix

Consistency Ratio (Consistency Ratio = CR) can be calculated using equation 2

\[
CR = \frac{CI}{RI}
\]

(2)

Table 1. Scale of Relative Importances (according Saaty)
In AHP, pairwise comparisons in the rating matrix are considered consistent if the consistency ratio (CR) is less than 10%. If the CR value is less than or equal to 0.10, the ratio made by the decision maker is correct.

RI (Random Index) is the average index for the consistency of numeric numbers randomly from the scale of 1/9, 1/8, ..., 1, 2, ..., 9 based on research conducted by Saaty. The value of RI can be seen in Table 2 [2]:

| Size of Matrix | RI      |
|---------------|---------|
| 1             | 0       |
| 2             | 0,58    |
| 3             | 0,9     |
| 4             | 1,12    |
| 5             | 1,24    |
| 6             | 1,32    |
| 7             | 1,41    |
| 8             | 1,45    |
| 9             | 1,49    |
| 10            |         |

2.2. Technique For Order Preference By Similarity To Ideal Solution (TOPSIS)

[6] stated that the Technique for ordering preference by similarity to an ideal solution (TOPSIS) is a classic Multi Attribute Decision Making (MADM) method developed by Hwang and Yoon. TOPSIS helps decision makers develop issues to analyze, compare and rank according to their alternate ratings.

TOPSIS is based on the concept of the closest alternative choice of a positive ideal solution (PIS) and furthest from the ideal ideal solution (NIS). The sum of the highest values of each attribute is called a positive ideal solution (PIS). The sum of the lowest values of each attribute is called the ideal ideal solution (NIS). Based on a comparison of the relative distance of PIS and NIS, alternative priority arrangements can be achieved [6][17].

TOPSIS advantages: (1) Human choice is represented by logical thinking, (2) The concept is simple and easy to understand, (3) The computing process can be easily programmed into a spreadsheet, (4) Be able to measure the relative performance of decision alternatives in simple mathematical form.

Step of TOPSIS method:
1. Normalized the decision matrix

   Normalization decision matrix can be calculated using eq (1)

   \[ \eta_{ij} = \frac{y_{ij}}{\sqrt{\sum_{i=1}^{m} \sum_{j=1}^{n} y_{ij}^2}} \]  

   whereas \( i = 1, 2, ..., m; \text{ and } j = 1, 2, ..., n. \)

   Create a normalized weighted decision matrix.

   \[ w_{ij} = \frac{\eta_{ij}}{\sum_{j=1}^{n} \eta_{ij}} \]  

   whereas \( i = 1, 2, ..., m; \text{ and } j = 1, 2, ..., n. \)

2. Determined the matrix of positive ideal solutions (PIS) and the ideal solution matrix (NIS).

   Normalized weights in the decision matrix \( (y_{ij}) \) are used to determine the ideal ideal solution of \( A^+ \) and the ideal solution of negative \( A^- \):

   \[ A^+ = (y_{11}^+, y_{21}^+, ..., y_{n1}^+) \]  

   \[ A^- = (y_{11}^-, y_{21}^-, ..., y_{n1}^-) \]  

   whereas

   \[ y_{ij}^+ = \begin{cases} \max_i y_{ij} & \text{if } j \text{ is a benefit attribute} \\ \min_i y_{ij} & \text{if } j \text{ is a cost attribute} \end{cases} \]  

   \[ y_{ij}^- = \begin{cases} \min_i y_{ij} & \text{if } j \text{ is a benefit attribute} \\ \max_i y_{ij} & \text{if } j \text{ is a cost attribute} \end{cases} \]  

   \( j = 1, 2, ..., n. \)
4. Determine the distance between an alternative value with a positive ideal solution matrix and an ideal negative solution matrix. The distance between \( A_i \) alternatives with positive ideal solution values is formulated as:

\[
D_i^+ = \sqrt{\sum_{j=1}^{n}(x_{ij}^+ - \gamma_j^+)^2}; \quad i = 1, 2, \ldots, m.
\]  

(9)

The distance between \( A_i \) alternatives with the ideal solution value is formulated as:

\[
D_i^- = \sqrt{\sum_{j=1}^{n}(x_{ij}^- - \gamma_j^-)^2}; \quad i = 1, 2, \ldots, m.
\]  

(10)

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

\[
V_i = \frac{D_i^-}{D_i^+ + D_i^-}; \quad i = 1, 2, \ldots, m.
\]  

5. Ranking Alternatives

The CI + sequence is used to rank so that the best alternative is the shortest distance to the ideal positive solution and has the furthest distance to the negative-ideal solution.

### 2.3. Weighted Product (WP)

The Weighted Product (WP) method uses the normalization process. This process uses multiplication to generate an attribute rating. Weighted Product (WP) is another scoring method where the weighted product of the parameter is used to select the best alternative [18]. Preferences for alternative \( A_i \) are given as follows:

\[
S_i = \prod_{j=1}^{n} x_{ij}^{w_j}; \quad i = 1, 2, \ldots, m.
\]  

(12)

whereas \( \sum w_j = 1 \).

\( w_j \) is a positive rank for the benefit attributes and a negative value for the cost attribute. The relative preferences of each alternative are defined as:

\[
V_i = \frac{\prod_{j=1}^{n} x_{ij}^{w_j}}{\prod_{j=1}^{n} (x_j)^{w_j}}; \quad i = 1, 2, \ldots, m.
\]  

(13)

The greatest value of \( V_i \) indicates that the alternative \( A_i \) is preferred.

### 2.4. Simple Additive Weighting (SAW)

The SAW (Simple Additive Weighting) method is a weighted sum method. The basic principle of SAW is to find a weighted sum of performance ratings on each alternative on all attributes. Simple Additive Weighting method is a weighted summation method, however prior to the performance value summation of each alternative on all attributes, this method will first execute the normalization process of the decision matrix to scale that can be compared with all the ratings of existing alternatives [19].

\[
\begin{align*}
\frac{x_{ij}}{\max x_{ij}} & \quad \text{if } j \text{ is a benefit attribute} \\
\frac{i}{x_{ij}} & \quad \text{if } j \text{ is a cost attribute}
\end{align*}
\]  

(14)

\( x_{ij} \) is the normalized working rating of the alternative \( A_i \) on the attribute \( C_j \); \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \). The preference values for each alternative \( V_i \) are formulated as:

\[
V_i = \sum_{j=1}^{n} w_j \tau_{ij}
\]  

(15)

The alternative chosen is the alternative that has the highest \( V \) value.
3. Result and Discussion

The problems in the selection of electrical experts or Electrical expert aim to get experts who have parameters as per the requirements of the Agency for Construction Services. Construction of Services Agency is implemented by a competency test for experts in electrical construction. The electrical experts who have qualification will receive a certificate of competence after they have passed a competency test. The Electrical experts fulfil administrative requirements before taking the competency test. The competency test consists of 4 exam materials. The test material is a parameter of decision-making. These parameters include of P1 (written test), P2 (test of theoretical knowledge), P3 (practice knowledge test), and P4 (oral test). The problems in the selection of Electrical expert can be represented in Figure 1. There are three steps of Electrical expert selection.

The parameters used in the process of Electrical expert selection are determined by the weight using a model of Analytic Hierarchy Process (AHP). These four parameters are compared to the level of importance using pairwise comparison matrix. The scale used in the pairwise comparison matrix is the scale of Saaty as shown in Table 1. Normalization matrix is required during the process of weighting.

Table 3. Pairwise Comparison Matrix

|     | P1    | P2    | P3    | P4    |
|-----|-------|-------|-------|-------|
| P1  | 1     | 0.200 | 0.333 | 0.333 |
| P2  | 5     | 1     | 0.333 | 3     |
| P3  | 7     | 3     | 1     | 5     |
| P4  | 3     | 0.333 | 1     | 1     |

Table 3 shows the pairwise comparison matrix. Following normalization, the weights are averaged across the rows to give an average weight of each parameter. Calculation of CR and CI was performed with reference to the theoretical explanation, equation (1) and (2).

\[
\lambda_{max} = 4.11 \\
C1 = 0.0396 \\
CRI = 0.0440
\]

Scoring pairwise comparison matrix elements are consistent, as shown by the calculation of CR values less than 0.1. CR value of pairwise comparison matrix is 0.0439774. It could be concluded that all comparison were consistent.

Weighting parameters resulted from the process of calculation are as follows

- P1 (written test) 0.055022
- P2 (test of theoretical knowledge) 0.263378
- P3 (practice knowledge test) 0.563813
- P4 (oral test) 0.117786

The test data is used as a parameter in the selection of an Electrical expert is shown in Table 4.

Tabel 4. Test Data

| Alternatives | Parameters |
|--------------|-----------|
|              | P1 | P2 | P3 | P4 |
| EE 1         | 0.6024 | 0.7500 | 0.5000 | 0.5000 |
| EE 2         | 0.5882 | 0.2500 | 0.7500 | 1 |
| EE 3         | 0.6353 | 1 | 1 | 1 |
| EE 4         | 0.6211 | 0.5000 | 0.5000 | 0.5000 |
| EE 5         | 0.5675 | 0.7500 | 1 | 0.7500 |
| EE 6         | 0.6369 | 0.7500 | 1 | 1 |
| EE 7         | 0.5747 | 0.5000 | 0 | 0 |
| EE 8         | 0.5464 | 0.7500 | 1 | 1 |
| EE 9         | 0.6993 | 0.5000 | 1 | 1 |
| EE 10        | 0.5618 | 0.7500 | 1 | 1 |
The match rate for each parameter is evaluated based on the weight assigned to that parameter. The weights of each parameter are shown in Table 5.

| Parameters | Weight |
|------------|--------|
| P1         | 0.25   |
| P2         | 0.75   |
| P3         | 1      |
| P4         | 0.5    |

After weighting the parameters then the next step is making the decision matrix up to the alternative ranking using TOPSIS method. The process of normalization matrix is calculated using equation (1).

Results normalization matrix can be seen in Table 6.

| Alternatives | Parameters | P1 | P2 | P3 | P4 |
|--------------|------------|----|----|----|----|
| EE 1         |            | 0.0474 | 0.9753 | 0.2819 | 0.0589 |
| EE 2         |            | 0.0463 | 0.0658 | 0.4229 | 0.1178 |
| EE 3         |            | 0.0421 | 0.2634 | 0.5638 | 0.1178 |
| EE 4         |            | 0.0488 | 0.1317 | 0.2819 | 0.0589 |
| EE 5         |            | 0.0447 | 0.1976 | 0.5638 | 0.0883 |
| EE 6         |            | 0.0512 | 0.1976 | 0.5638 | 0.1178 |
| EE 7         |            | 0.0452 | 0.1976 | 0.5638 | 0.1178 |
| EE 8         |            | 0.4230 | 0.1976 | 0.5638 | 0.1178 |
| EE 9         |            | 0.0550 | 0.1317 | 0.5638 | 0.1178 |
| EE 10        |            | 0.0442 | 0.1975 | 0.5638 | 0.1178 |

The next step is to rank the alternatives. The normalized decision matrix is weighted normalized matrix process. The weighted normalized matrix is obtained by multiplying the weight matrix normalized parameters obtained from pairwise comparison matrices. Normalized weighted matrix is calculated using the equation (2). The resulting normalized weighted matrix can be seen in Table 7.

| Alternatives | Parameters | P1 | P2 | P3 | P4 |
|--------------|------------|----|----|----|----|
| EE 1         |            | 0.0474 | 0.9753 | 0.2819 | 0.0589 |
| EE 2         |            | 0.0463 | 0.0658 | 0.4229 | 0.1178 |
| EE 3         |            | 0.0421 | 0.2634 | 0.5638 | 0.1178 |
| EE 4         |            | 0.0488 | 0.1317 | 0.2819 | 0.0589 |
| EE 5         |            | 0.0447 | 0.1976 | 0.5638 | 0.0883 |
| EE 6         |            | 0.0512 | 0.1976 | 0.5638 | 0.1178 |
| EE 7         |            | 0.0452 | 0.1976 | 0.5638 | 0.1178 |
| EE 8         |            | 0.4230 | 0.1976 | 0.5638 | 0.1178 |
| EE 9         |            | 0.0550 | 0.1317 | 0.5638 | 0.1178 |
| EE 10        |            | 0.0442 | 0.1975 | 0.5638 | 0.1178 |

The next step is to determine the positive ideal solution (PIS) and negative ideal solution (NIS), then to determine the distance of each alternative with positive ideal solution and negative ideal solution (eq 3-6). Normalized weights in the decision matrix (yij) is used to determine the positive ideal solution A+ and negative ideal solution A-. Vj and Vj- value for each parameter are as follows:

P1 (Vj+ = 0.055022 and Vj = 0.042121)
P2 (Vj⁺ = 0.263378 and Vj⁻ = 0.065845)
P3 (Vj⁺ = 0.563813 and Vj⁻ = 0)
P4 (Vj⁺ = 0.117786 and Vj⁻ = 0)

Positive ideal solution and negative ideal solution of each alternative are shown in Table 8

| Alternatives | PIS     | NIS     |
|--------------|---------|---------|
| EE 1         | 0.087333| 0.100311|
| EE 2         | 0.058964| 0.192707|
| EE 3         | 0.000166| 0.370778|
| EE 4         | 0.100319| 0.320734|
| EE 5         | 0.004346| 0.343118|
| EE 6         | 0.004346| 0.343118|
| EE 7         | 0.349197| 0.040345|
| EE 8         | 0.004448| 0.349101|
| EE 9         | 0.017342| 0.336260|
| EE 10        | 0.04453 | 0.336260|

The next step is determining the distance between the value of each alternative with positive ideal solution matrix (D⁺) and the distance between the value of each alternative with negative ideal solution matrix (D⁻). The distance between the alternative with positive and negative ideal solution can be formulated by the equation (7-8). Distance weighted value of each alternative to the positive ideal solution and negative ideal solution can be seen in Table 9.

| Alternatives | D⁺   | D⁻   |
|--------------|------|------|
| EE 1         | 0.29553 | 0.316717 |
| EE 2         | 0.24391 | 0.438977 |
| EE 3         | 0.301   | 0.608915 |
| EE 4         | 0.316733| 0.295501 |
| EE 5         | 0.066027| 0.585694 |
| EE 6         | 0.066027| 0.590901 |
| EE 7         | 0.590929| 0.065917 |
| EE 8         | 0.066934| 0.590848 |
| EE 9         | 0.131689| 0.579880 |
| EE 10        | 0.066728| 0.590851 |

Give preference value for each alternative. Preference value for each alternative (Vij) is given as eq (9). From the calculated value, alternative with the largest value of the best solution and the first priority is Electrical Expert (EE) 3 can be shown as table 10.

| Alternatives | Vij  | Rank |
|--------------|------|------|
| EE 1         | 0.517309| 8    |
| EE 2         | 0.643849| 7    |
| EE 3         | 0.979252| 1    |
| EE 4         | 0.482660| 9    |
| EE 5         | 0.898688| 3    |
| EE 6         | 0.899491| 2    |
| EE 7         | 0.100354| 10   |
| EE 8         | 0.898243| 5    |
| EE 9         | 0.814931| 6    |
| EE 10        | 0.898525| 4    |
When completed using the Weighted Product (WP) method, each attribute (table 4) is raised by the weight of the corresponding attribute using the equation (10).

\[
 w_1 = \frac{0.25}{0.25 + 0.75 + 1 + 0.5} = 0.1
\]

Using the same way for the next rating is obtained: \( w_2 = 0.1875, w_3 = 0.25, w_4 = 0.125 \). Vector S is calculated using equation [11]. The result of each S value can be seen in table 11.

The final step of the WP method is to sort the alternate priorities using equation (11), resulting in a vector V as shown in table 11.

| Alternatives | \( S_i \) | \( V_i \) | Rank |
|--------------|----------|----------|------|
| EE 1         | 0.8380   | 0.0906   | 8    |
| EE 2         | 0.8658   | 0.0937   | 7    |
| EE 3         | 1.2523   | 0.1137   | 1    |
| EE 4         | 0.7680   | 0.1209   | 4    |
| EE 5         | 1.0674   | 0.1152   | 5    |
| EE 6         | 1.1176   | 0.1297   | 2    |
| EE 7         | 0        | 0        | 10   |
| EE 8         | 1.1748   | 0.1271   | 2    |
| EE 9         | 0.9998   | 0.1082   | 6    |
| EE 10        | 1.1611   | 0.1256   | 3    |

Based on the calculation of relative preference V found that electric experts 3 has the highest value and he/she is the best alternative.

If solved by Simple Additive Weighting (SAW) method, from table 4 matrix normalization using equation (12). After normalized then calculated the value of V using equation (13). The results can be seen in table 12.

| Alternatives | \( V_i \) | Rank |
|--------------|----------|------|
| EE 1         | 2.734615 | 8    |
| EE 2         | 3.009936 | 7    |
| EE 3         | 3.948429 | 1    |
| EE 4         | 2.520513 | 9    |
| EE 5         | 3.395000 | 5    |
| EE 6         | 3.559615 | 4    |
| EE 7         | 1.723077 | 10   |
| EE 8         | 3.724359 | 2    |
| EE 9         | 3.293910 | 6    |
| EE 10        | 3.686538 | 3    |

The algorithm of each MADM method is different. AHP uses the hierarchy principle and pairwise comparison matrices to select the obtained alternative rankings. WP and SAW apply the principle of weighted average by assigning a scale value to each alternative. TOPSIS calculates the shortest distance of an alternative from the positive ideal solution and the longest distance from the negative-ideal solution. AHP provides consistency in judgement considering that the consistency index is calculated before creating pairwise comparison matrices, WP, SAW and TOPSIS cannot provide controlled consistency because they have no comparative indexes as indicators. AHP, SAW and WP focus on a model from which a vector of global scores is obtained by competing alternatives. TOPSIS is classified under compromising models, with the notion that no ideal solution exists, but a solution with optimal values on all attributes is simultaneously selected. AHP cannot be used when numerous criteria and alternatives are involved. TOPSIS is applicable when large numbers of alternatives and
criteria are involved because the TOPSIS algorithm is direct and causes no complication in calculation despite the large-scale data. The TOPSIS focuses on the relative importance between alternatives compared to other compensatory aggregative methods. This effect is derived from the following factors: (1) two reference points (positive ideal solution and negative ideal solution) are obtained in accordance with the tested alternatives and (2) this method uses Euclidean distance to calculate proximity alternatively with reference point. WP and SAW are suitable for decision making with many parameters and alternatives. AHP is a MADM method that has consistency in giving weighting to its parameters while TOPSIS, SAW and WP methods have no consistency.

The results of the highest alternative selection for electric experts who are expressed have the ability to competence using three methods of decision making many attributes (Multi Attribute Decision Making). The three results using hybrid AHP-TOPSIS, WP or SAW method shows the highest alternative to the fifth alternative is the same. For results using WP and SAW methods show the same results on priority for all alternatives. The full results can be seen in Table 13.

Table 13. Results Comparison of Each Method

| Alternatives | WP Value | WP Rank | SAW Value | SAW Rank | HYBRID (AHP-TOPSIS) Value | HYBRID Rank |
|--------------|----------|---------|-----------|----------|---------------------------|-------------|
| EE 1         | 0.090648 | 8       | 2.734615  | 8        | 0.53217                  | 8           |
| EE 2         | 0.093656 | 7       | 3.009936  | 7        | 0.643849                 | 7           |
| EE 3         | 0.135463 | 1       | 3.948429  | 1        | 0.798252                 | 1           |
| EE 4         | 0.083073 | 9       | 2.596513  | 9        | 0.482660                 | 9           |
| EE 5         | 0.115454 | 5       | 3.59875   | 5        | 0.898688                 | 3           |
| EE 6         | 0.120888 | 4       | 3.59919   | 4        | 0.899491                 | 2           |
| EE 7         | 0        | 10      | 1.2577    | 9        | 0.100354                 | 10          |
| EE 8         | 0.127077 | 2       | 2.4359    | 2        | 0.898243                 | 5           |
| EE 9         | 0.108158 | 6       | 2.0310    | 6        | 0.814931                 | 6           |
| EE 10        | 0.117190 | 3       | 3.58128   | 3        | 0.898525                 | 4           |

4. Conclusion

A comparative study of different MADM methods was performed in this paper based on case study of the electrical expert selection. The process of evaluating and determining the electrical expert in a competency test involves many variations of parameters. The AHP method, TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), WP (Weighted Product) and SAW (Simple Additive Weighting) are used to solve the problem of decision making of electrical expert determination through competency test. This study compares the MADM method with the purpose of selecting the best electrical expert (EE). The differences in rank order of these methods are due to the effects of alternative values, weighting criteria, and the calculation method. The result of decision making process using WP and SAW method shows the same result for alternatives rank. Basically WP and SAW methods have the same core process that is the principle of calculating the average weighting parameters. The use of the AHP-TOPSIS hybrid method in the decision making process yields the same top rank as the other methods. There are 3 different ranking positions of results using other methods. The result of using this hybrid method is more valid because through the process of AHP method. The AHP process is weighted on its parameters with measurable consistency. The next process is through TOPSIS method for the alternative ranking process.
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