Comparison AHP and SAW to promotion of head major
department SMK Muhammadiyah 04 Medan

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Abstract: Decision Support System (DSS) is a system that can help a person to make informed decisions about various types of choices that are performed accurately and in accordance with the desired goals. Many problems can be solved by using decision support systems. In this journal the decision support system is used to assist the Chief of Muhammadiyah Medan branch in the selection of the department chief. The criteria used for the election of department chiefs are: Loyalty, Job Performance, Responsibility, Obedience, Honesty, Cooperation, Education, and Leadership. The selection promotion process consists of Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods. The data were obtained through teacher assessment questionnaires by principals and colleagues. The results of this study used a comparison with two decision methods namely SAW method and AHP method so that the decision maker (principal) is more appropriate in the determination of candidates who will be elected head of department at school. The final result of this research is the first rank obtained by muhammad musa with weight value on AHP method (0.274) and weight value on SAW method (0.993), alvin syahrin with weight value on AHP method (0.241) and weight value on SAW method (0.883), noviyanti with weight value on AHP method (0.193) and weight value on SAW method (0.707). So the conclusion on the research that is by using SAW method the value of weight produced more accurate.

1. Introduction
Branch Chief Muhammadiyah Medan has prioritized efforts to improve the quality of education of students of SMK Muhammadiyah Medan, in anticipating the challenges ahead towards the desired concept, it is necessary to continuously develop opportunities and innovations so that the goals can be achieved maximally. Based on the description of the problem, it is necessary to build a decision support system of the promotion of the position of head of department of SMK Muhammadiyah 04 Medan as a solution to the problem of determining the selection process or promotion of existing positions. To overcome these problems with the AHP (Analytical Hierarchy Process) method solves a complex problem where aspects or criteria are taken quite a lot and the method of SAW (Simple Additive Weighting) is often also known term weighted summation. Other researchers usually use one method of completion of the election of a particular candidate. Therefore the author uses two methods in the completion of the election of candidates. With two outcomes from two different methods will raise the confidence of decision makers to complete the election of a particular candidate.
2. Theoretical Basis

2.1 Decision Support System

According to Bonczek in the book [1], Decision support system as a computer-based system consisting of components such as components of the language system, knowledge system components and components of the problem processing system that interact with each other. According to Alter in the book [2], decision support system is an interactive information system that provides information, modeling, and data manipulation where the system used to assist decision making in semi-structured and unstructured situations. The thing to note here is that the existence of DSS is not to replace the duties of managers, but to be a means of supporting them. SPK is an implementation of theory of decision theory that has been introduced by science such as operations research and management science. The only difference is that in the past, to solve the problems encountered, the calculation of iterations must be done manually [3]. According to decision support system components are [4]: data management, model management, subsystem dialog, knowledge management.

2.2 Analytic Hierarchy Process

Analytic Hierarchy Process or AHP developed by Prof. Thomas L. Saaty as the decision-making algorithm for multicriteria problems (Multi Criteria Decision Making or MCDM)[5]. The multicriteria problem in AHP is simplified in the form of hierarchy consisting of 3 main components[6]. Analytic Hierarchy Process (AHP) can simplify complex and unstructured problems, strategies and dynamics become part of it, and make variables in a hierarchy (level). A complex problem can be interpreted as the criteria of a problem that is so much (multi criteria)[7]. That is the goal or goal of decision making, assessment criteria and alternative choice[8]. Multi Criteria Decision Making (MCDM) approaches are more popular and widely acceptable for complex decision making problems. MCDM methods are used to find the best alternative by evaluating the conflict criterion. Analytical Hierarchical Process (AHP) is one of the widely accepted MCDM approaches which are accepted by researchers because of its nature to make optimal and best decisions [9]. The image of the hierarchy is as follows:

**Figure 1.** Hierarchy Analysis Process.

Pattern of Ratio Consistency: \[ CR = \frac{CI}{RI} \] (1)
CR is a parameter used for check if the pairwise comparison has been done consequently or not. The value of RI is the random value of the index issued by Oakridge laboratory such as which is shown in Table 1 below[10]:

| Ordo | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | 14 | 15 |
|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Indeks Random | 0,00 | 0,58 | 0,90 | 1,12 | 1,24 | 1,32 | 1,41 | 1,45 | 1,49 | 1,51 | 1,48 | 1,56 | 1,57 | 1,59 |

Calculation of consistency index (CI), measurement this is meant to know consistency answers that will affect the validity results. The formula is as follows:

\[ CI = \left( \frac{\lambda_{\text{max}} - n}{n - 1} \right) \]  \hspace{1cm} (2)

To know if CI is by magnitude certain good enough or not, please note the ratio is considered good, if:

\[ CR \leq 0.1 \]  \hspace{1cm} (3)

2.3 *Simple Additive Weighted*

Simple Additive Weighting (SAW) method is often also known as weighted summing method. The basic concept of the SAW method is to find the weighted sum of performance ratings on each alternative on all attributes [11]. Simple Additive Weighting (SAW) method is often also known as weighted summing method. The basic concept of the SAW method is to find the weighted sum of performance ratings on each alternative on all attributes [12]. The SAW method requires the process of normalizing the decision matrix (X) to a scale comparable to all existing alternative ratings [13]. This method is the most famous and most widely used method of dealing with Multiple Attribute Decision Making (MADM) situations. MADM itself is a method used to find the optimal alternative of a number of alternatives with certain criteria (This SAW method requires decision makers to assign weights to each attribute) [14]. The total score for the alternative is obtained by summing all the results of the multiplication between the ratings (which can be compared across attributes) and the weight of each attribute. The rating of each attribute must be dimensionless in the sense that it has passed the normalization process of the previous matrix [15]. Pattern normalization:

\[
r_{ij} = \begin{cases} 
\frac{X_{ij}}{\text{Max}_i \cdot X_{ij}} & \text{If } j \text{ is attribute benefit} \\
\frac{X_{ij}}{\text{Min}_i \cdot X_{ij}} & \text{If } j \text{ is attribute cost} 
\end{cases} \]  \hspace{1cm} (4)  \hspace{1cm} (5)

Pattern of preferency: \( V_i = \sum_{j=1}^{n} W_j \cdot r_{ij} \)
3. The Result

3.1 Scheme of Analytic Hierarchy Process
The first step in getting a consistency value is to calculate \( \lambda \) max first. \( \lambda \) max = 8.470, then calculate Consistency Index (CI) using equation (2): Calculate Consistency Ratio (CR) using Ratio Index equation used CR = (0.0671) / 1.41 = 0.0476. The Consistency Ratio value obtained shows that \( \leq 0.1 \), which indicates that the weight of the generated criteria has been feasible to use. Counting Weight Results priority of the calculation results are poured in the results of weight using AHP method based on the criteria can be seen in Table 2.

**Table 2.** Results Weights using AHP Method based on criteria.

| Criteria   | Loyalty | Job Performance | Responsibility | Obedience | Honesty | Coopération | Education | Leadership |
|------------|---------|-----------------|----------------|-----------|---------|-------------|-----------|------------|
| Eigen Vector | 0.184   | 0.155           | 0.140          | 0.139     | 0.110   | 0.102       | 0.084     | 0.086      |

From the calculation using AHP method based on the criteria, it can be concluded that the highest weight value is in the loyalty criterion with the value 0.184, then the lowest value of weight on the Initiative criteria with the value of 0.084. The results of alternative calculations based on the criteria weighting can be seen in Table 3.

**Table 3.** Alternative Results Using AHP Methods Based on Criteria.

| Criteria    | Loyalty | Job Performance | Responsibility | Obedience | Honesty | Coopération | Education | Leadership | Final Result | Rank |
|-------------|---------|-----------------|----------------|-----------|---------|-------------|-----------|------------|---------------|------|
| Eigen Vector | 0.184   | 0.155           | 0.140          | 0.139     | 0.110   | 0.102       | 0.084     | 0.086      |               |      |
| M. Musa     | 0.261   | 0.267           | 0.254          | 0.319     | 0.284   | 0.286       | 0.226     | 0.291      | 0.274         | 1    |
| Alvin Syahrin | 0.256   | 0.259           | 0.255          | 0.217     | 0.202   | 0.249       | 0.220     | 0.247      | 0.241         | 2    |
| Noviyanti   | 0.194   | 0.163           | 0.166          | 0.166     | 0.194   | 0.198       | 0.198     | 0.193      | 0.193         | 3    |
| Sofia       | 0.141   | 0.189           | 0.167          | 0.153     | 0.142   | 0.146       | 0.182     | 0.150      | 0.158         | 4    |
| Syaiful Aswad | 0.148   | 0.123           | 0.105          | 0.146     | 0.142   | 0.125       | 0.174     | 0.131      | 0.135         | 5    |

3.2 Scheme of Simple Additive Weighted
Ranking using SAW method with steps:
1. Decision Matrix
The data used are Candidate List of Head major Department of SMK Muhammadiyah 04 Medan as many as 5 people sample. Seen in Table 3 consisting of criteria such as Loyalty (C1), Job Performance (C2), Responsibility (C3), Obedience (C4), Honesty (C5), Cooperation (C6), Initiatives (C7) and Leadership C8) and alternatives consisting of Muhammad musa (A1), Sofia (A2), Noviyanti (A3), Alvin Syahrin (A4) and Syaiful Aswad (A5). Result of decision matrix can be seen in Table 4.

**Table 4.** Decision Matrix.

| Criteria  | C1     | C2     | C3     | C4     | C5     | C6     | C7     | C8     |
|-----------|--------|--------|--------|--------|--------|--------|--------|--------|
| M. Musa   | 0.261  | 0.267  | 0.254  | 0.319  | 0.284  | 0.286  | 0.226  | 0.291  |
| Alvin Syahrin | 0.256  | 0.259  | 0.255  | 0.217  | 0.202  | 0.249  | 0.220  | 0.247  |
| Noviyanti | 0.194  | 0.163  | 0.218  | 0.166  | 0.230  | 0.194  | 0.198  | 0.193  |
| Sofia     | 0.141  | 0.189  | 0.167  | 0.153  | 0.142  | 0.146  | 0.182  | 0.150  |
| Syaiful Aswad | 0.148  | 0.123  | 0.105  | 0.146  | 0.142  | 0.125  | 0.174  | 0.135  |
1. Normalization of Matrices
Normalization of matrices based on equations with reference all attributes is a benefit or benefit, can be seen in Table 5.

|           | C1    | C2    | C3    | C4    | C5    | C6    | C7    | C8    |
|-----------|-------|-------|-------|-------|-------|-------|-------|-------|
| M. Musa   | 1.000 | 1.000 | 0.995 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Alvin Syahrin | 0.983 | 0.970 | 1.000 | 0.680 | 0.711 | 0.872 | 0.975 | 0.847 |
| Novi yanti | 0.745 | 0.610 | 0.854 | 0.521 | 0.808 | 0.679 | 0.877 | 0.657 |
| Sofia     | 0.539 | 0.708 | 0.656 | 0.479 | 0.500 | 0.510 | 0.808 | 0.514 |
| Syaiful Aswad | 0.565 | 0.462 | 0.410 | 0.458 | 0.500 | 0.439 | 0.771 | 0.416 |

2. Ranking Process
Determination of ranking process by using weight which have been obtained from Decision Maker of SMK Muhammadiyah 04 Medan then process ranking with SAW method:

\[ W = [0.16; 0.15; 0.14; 0.13; 0.12; 0.11; 0.09; 0.10] \]

The final result is obtained by calculating multiplication matrix with weighted value. For example, Muhammad musa with initials A1 has the normalization value of each criterion (1,000,1,000, 0.995, 1,000, 1,000, 1,000, 1,000, 1,000) multiplied by weighted (0.16; 0.15; 0.14; 0.13; 0.12; 0.11; 0.09; 0.10 ) then the result is 0.993. Etc. The results can be seen in Table 6.

| Rangking | Alternative     | Value   |
|----------|----------------|---------|
| 1        | Muhammad musa  | 0.993   |
| 2        | Alvin Syahrin  | 0.883   |
| 3        | Novi yanti     | 0.707   |
| 4        | Sofia          | 0.578   |
| 5        | Syaiful Aswad  | 0.490   |

4. Conclusions
From the results of research and discussion undertaken conclusions can be drawn as follows:

- Using AHP method makes it easier to make weighted value but not easier to make decision. Then better both of method to combination, not comparison.
- Using two methods as a comparison it will raise the confidence of school leaders in deciding who can become head of department TKJ SMK Muhammadiyah 04 Medan.
- Between the AHP and SAW methods indicates that the 1st rank is occupied by the same alternative but the difference is each of its values. SAW method shows a higher number of AHP methods.
- Selection of Promotion of Candidates Officials based on the criteria in this research has been determined that is Loyalty.

References
[1] Efraim Turban, et al. 2005. Decision Support System and Intelligent Systems Edisi 7 Jilid 1, Andi Yogyakarta.
[2] Kadarsah, Suryadi. 2003. Sistem Pendukung Keputusan, PT.Remaja Rosdakarya Bandung.
[3] Kusrini, 2007. Konsep dan Aplikasi Sistem Pendukung Keputusan. Yogyakarta. Penerbit Andi.
[4] Subakti, I., 2002, *Sistem Pendukung Keputusan*, Jurusan Teknik Informatika, Fakultas Teknologi Informasi, Institut Teknologi Sepuluh Nopember, Surabaya. 
http://muhayat.com/downloads/Kuliah%2020%20Decision%20Support%20Systems.pdf 29 April 2011.

[5] Saaty, T.L. 2001. *Decision Making For Leaders*. Forth edition, University of Pittsburgh, RWS Publication.

[6] Anjali Singh, et. Al. 2015. *An AHP-PROMETHEE II Method for 2-tuple Linguistic Multicriteria Group Decision Making*. 978-1-4673-7231-2/15/$31.00. IEEE.

[7] Goyal, R.K. & Kaushal, S. 2015. *Effect of Utility Based Functions on Fuzzy-AHP based network selection in heterogenous wireless networks*. RAECS UIET Panjab University Chandigarh 21-22th.

[8] Balubaid, Mohammed and Alamoudi, Rami. 2015. *Application of the Analytical Hierarchy Process (AHP) to Multi-Criteria Analysis for Contractor Selection*. American Journal of Industrial and Business Management, 5, 581-589.

[9] Brijendra Singh, 2015. *Analytical Hierarchical Process (AHP) and Fuzzy AHP Applications Review Paper*. International Journal of Pharmacy and Technology. ISSN: 0975-766X.

[10] Marimin. 2004. *Teknik dan Aplikasi Pengambilan Keputusan Kriteria Majemuk*. Penerbit PT Grasindo, Jakarta.

[11] Rahmawati, N.F, Wibawa, H.A. & Bahtiar, N. 2013. *Sistem Pendukung Keputusan Pemilihan Penerima Beasiswa Dengan Metode Simple Additive Weighting (Studi Kasus Di SMA N 1 Karanganyar Kebumen)*. Journal of Informatics and Technology 2(3): 59-65.

[12] Kahraman, C., Cebeci, U. & Ulukan, Z. 2003. *Multi-Criteria Supplier Selection Using Fuzzy AHP*. Logistics Information Management 16(6): 382-394.

[13] Azizollah Memariani. 2009. *Sensitivity Analysis of Simple Additive Weighting Method (SAW): The Results of Change in the Weight of One Attribute on the Final Ranking of Alternatives*. Journal of Industrial Engineering 4: 13 - 18.

[14] Adriyendi. 2015. *Multi-Attribute Decision Making Using Simple Additive Weighting and Weighted Product in Food Choice*. I.J. Information Engineering and Electronic Business, 6, 8-14.

[15] Balaji, N., Sambasivam, G., Murugaiyan, S.R., Basha, M.S.S., Vengattaraman, T. & Dhavachelvan, P. 2013. *Appraisal and Analysis on Diversified Web Service Selection Techniques based on QoS Factors*. International Journal of Engineering and Technology (IJET), 5(3): 3012 - 3019.