pISSN: 2715-6923, eISSN: 2721-9186
https://jurnal.unimus.ac.id/index.php/ichi

Journal of Intelligent Computing and Health Informatics

Supplier Selection Very Small Aperture Terminal using AHP-TOPSIS Framework

Research Article

Sumanto[1*], Karlena Indriani[1], Lita Sari Marita[1], Ade Christian[2]

1. *Department of Information Systems, Universitas Bina Sarana Informatika, jakarta 10450, Indonesia*
2. *Department of Technical Information, STMIK Nusa Mandiri Jakarta, jakarta 10450, Indonesia*

[*]Sumanto@bsi.ac.id (coresponden author)
karlena.bsi.ac.id
lita.lsm@bsi.ac.id
ade.adc@nusamandiri.ac.id

Article history :
Received : 17 Agt 2020
Accepted : 17 Sep 2020
Available online : 30 Sep 2020

ABSTRACT

There are several methods of decision making VSAT IT goods suppliers such as: Promethee, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Analytical Hierarchy Process (AHP). Decision-making in the selection of the best suppliers, we have the basis of assessment criteria, and we will also be faced with more than one alternative. If alternatives are only two, maybe still easy for us to choose, but if the alternative is a lot of choice, it is quite difficult for us to decide. Analytical Hierarchy Process (AHP) is a technique that was developed to help overcome this difficulty, because the Analytical Hierarchy Process (AHP) is a form of decision-making model with many criteria. One of the reliability of the Analytical Hierarchy Process (AHP) is able to perform simultaneous analysis and integrated between the parameters of qualitative or quantitative. In this study the authors use six criteria and alternatives 6, the results of these alternatives will be obtained perangkingan alternative used as a reference supplier selection VSAT IT goods company Total EP Indonesie.

Keywords : Topsis, AHP, supplier selection.

1. INTRODUCTION

In the present serious business sectors, organizations have understood the significance of advancing their business cycle. So as to remain serious, organizations need to improve their own exhibition as well as improve the presentation of all their gracefully chain accomplices (Sanayei, Farid Mousavi, & Yazdankhah, 2010).

Provider determination is one of the most significant movement of gracefully chain and the goal is choosing the most helpful provider with required item and additionally administration quality at the opportune spot, at the correct time, and in the correct amounts (Boran, Genç, Kurt, & Akay, 2009).

According to (Sangadji, 2013), selecting supplier options requires an analytical method that can overcome complex problems to obtain optimal results. Supplier selection is a multi-criteria decision-making (MCDM) problem that involves many criteria that are often conflicting (Ahmad, Yaakob, Gegov, & Kasim, 2019).

In designing an effective supply chain source, buyers must find a quality product or service provider that is suitable in the supplier selection process (Çalık, 2020). To solve these problems, the researcher will use Multi-Attribute Decision Making (MADM). The MADM method used in this study was AHP and TOPSIS. The Analytic Hierarchy Process (AHP) is a basic approach to decision making introduced by Thomas L. Saaty in 1980. The purpose of AHP is to assist in organizing thoughts and judgments to obtain more effective decisions. AHP can direct how to determine the priority of a series of alternatives and the relative importance of attributes in a Multi-Criteria Decision Making (MCDM) problem (Siregar, 2019).

Several IT VSAT decision making methods include: Promethee, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Analytical Hierarchy process (AHP). Decision making in selecting the best supplier, which is defined as the criteria as the basis for production, and we will also be faced with more than one alternative choice. If there are only two alternative options, maybe it is still easy for us to choose, but if there are many alternative options, it is quite difficult for us to decide. The Analytical Hierarchy Process (AHP) is a technique developed to help overcome this difficulty, because the Analytical Hierarchy Process (AHP) is one of the many models of decision making with multiple criteria. One of the reliability of the Analytical Hierarchy process (AHP) is that it can perform simultaneous and integrated analysis between qualitative or even quantitative parameters.

A satellite communication system is a communication system that uses satellites as a transmission medium to convey information, with systems all over the world being located without knowing their geographical conditions. This satellite communication system is very suitable for use in Indonesia, because Indonesia consists of many islands and is very broad. The satellite communication system consists of a sending earth station, a satellite and a receiving earth station. At the earth station the receiver is usually an antenna that is useful for receiving satellite signals. One of the technologies in the satellite communication system that is being developed is the Very Small Averture Antenna (VSAT).

Usually banking, oil and gas companies definitely need a VSAT service and also have many suppliers as Very Small Aperture Terminal (VSAT) service suppliers. VSAT service suppliers are an important part of the company. The selection of VSAT service suppliers must be done in a selective manner and is invincible with company conditions. What is meant by the condition of the company here is the financial condition, the condition of consumer demand, the supply of supplies and so on. Selection in the selection of a VSAT service supplier in the Company results in unsatisfied consumer demand. The selection of a VSAT service supplier becomes difficult and risky when the selection is repeated over a certain period of time. The selection of a VSAT service provider must be carried out using different criteria at each period.

The use of different criteria in each period occurs due to the influence of company conditions that are not fixed and change over time. In addition, the number of VSAT service suppliers to be selected for each period is sometimes not the same. This is also driven by the condition of the company which is not fixed and changes over time. The wrong supplier selection can worsen the entire supply chain, financial and operational ranking.

Selection of suppliers in this study using Farework AHP and TOPSIS integration. Based on the description above, supplier selection is an important activity within the company. Choosing the wrong supplier will provide VSAT service supplies that are not in accordance with company conditions. Also usually there are weaknesses in supplier selection made by companies whose decision makers only judge subjectively based on the price offered and the quality of VSAT services. Therefore, this study aims to select suppliers with more comprehensive and objective considerations. In this study, the AHP and TOPSIS framework will be used for optimal supplier selection. With this, banking, oil and gas companies, or other companies that use VSAT services can obtain references in selecting suppliers for VSAT services.

2. THE MATERIAL AND METHOD

In previous research, many have discussed the theme of selecting suppliers using the AHP-TOPSIS framework, to help practitioners and academics in solving problems in the field of supplier selection. This study uses a questionnaire instrument made using pairwise comparisons. In this study the authors use 7 criteria that will be used as an assessment of supplier selection according to journal references (Shahroudi & Rouydel, 2012), among others:

1. *PPM (Part Per Million) customers*
2. *Quality*
3. *Price/ cost*
4. *standardization*
5. *Service*
6. *Flexibility*
7. *On time delivery*

But in this study the authors only use 6 criteria including: Quality, Price / cost, standardization, Service, Flexibility, On time delivery. Due to the PPM (Part Per Million) criteria, customers considered it not in accordance with the criteria for several companies so that this research could be used globally.

2.1. Supply chain management

Supply chain is a network of companies that work together to create and deliver a product into the hands of end users (Lourenço & Ravetti, 2018). These companies are suppliers, factories, distributors, shops or retail, as well as supporting companies such as companies. logistics services. To manage a supply chain, you need an appropriate tool, method or approach known as Supply Chain Management (SCM).

A supply chain consists of all parties that are directly or indirectly involved in meeting customer demands. The supply chain includes not only manufacturers and suppliers, but also transporters, warehouses, retailers and even the customers themselves. In any organization, such as a manufacturer, the supply chain includes all the functions involved in receiving and filling customer requests. These functions include, but are not limited to, new product development, marketing, operations, distribution, finance, and customer service (Chopra & Meindl, 2007).

Supply Chain Management is one of the best solutions to improve productivity levels between different companies. The main goals of SCM are: delivery or delivery of products in a timely manner to satisfy consumers, reduce costs, improve all results from the entire supply chain (not just one company), reduce time, centralize planning and distribution activities (Lourenço & Ravetti, 2018).

The activity of selecting suppliers can take a lot of time and resources if the supplier in question is a key supplier. The difficulty will be higher if the selected suppliers are located overseas (global suppliers). For key suppliers with the potential for long-term relationships, this selection process may involve initial evaluation, inviting them for presentations, site visits and so on. This kind of process certainly takes a lot of time and money. It should also be noted that the selection of key suppliers must be in line with the supply chain strategy. If innovation is one of the keys to competition, the ability of suppliers to supply materials of different specifications may be an important consideration. Conversely, in a supply chain that competes on the basis of price, suppliers who offer goods at lower prices should be prioritized (Lourenço & Ravetti, 2018).

2.2. Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) is a decision support method developed by Thomas L. Saaty. This decision support model will describe a complex multi-factor or multi-criteria problem into a hierarchy. According to Saaty (1993), hierarchy is defined as a representation of a complex problem in a multilevel structure where the first level is the goal, followed by the level of factors, criteria, sub criteria, and so on until the last level of alternatives (Munthafa & Mubarok, 2017).

2.3. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is one of the multicriteria decision-making methods or alternative choices which are the alternatives that have the smallest distance from the positive ideal solution and the largest distance from the negative ideal solution from a geometric point of view using the Euclidean distance. However, the alternative which has the smallest distance from the positive ideal solution, does not have to have the largest distance from the negative ideal solution. Therefore, TOPSIS considers both the distance to the positive ideal solution and the distance to the negative ideal solution simultaneously. The optimal solution in the TOPSIS method is obtained by determining the relative proximity of an alternative to the positive ideal solution. TOPSIS will rank alternatives based on priority value of the relative proximity of an alternative to a positive ideal solution. The alternatives that have been ranked are then used as references for decision makers to choose the best desired solution (Sumanto & Sumarna, 2019).

3. RESULT AND DISCUSSION

3.1. Research approach framework

In this study using a quantitative research approach. It is called quantitative research because it is carried out systematically on parts and phenomena and their relationships. The objective of quantitative research is to develop and use mathematical models, theories and / or hypotheses. The statistical data were obtained from a questionnaire using the Analytical Hierarchy Process (AHP) and TOPSIS approach, then tested using the Expert Choice 2011 tool or software.

3.2. Research instrument

In this study, the questionnaire instrument was used together with pairwise comparisons, generally using 7 criteria that would be used as an assessment for supplier selection, including PPM (Part Per Million) customers; Quality; Price/ cost; standardization; Service; Flexibility; On time delivery.

But in this study we only used 6 criteria including: Quality, Price / cost, standardization, Service, Flexibility, On time delivery. Due to the PPM (Part Per Million) criteria customers do not match the criteria for the company that is the object of research. Figure 1, shows the hierarchy of supplier selection strategies that have been adjusted to the criteria and alternatives.

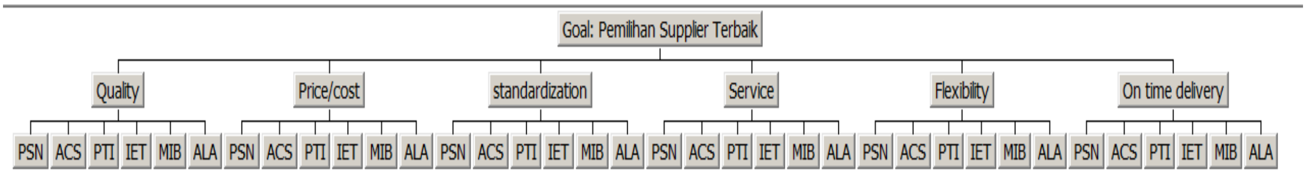

Fig. 1. Hierarchy of strategy for selecting equipment supplier for IT VSAT goods.

The hierarchy of interests is used to describe the problem for clarity. Hierarchy of interests in research on determining the best supplier. Level 1 is an overall objective, namely the criteria for supplier assessment. Level 2 is a criterion, and level 3 is an alternative. There are 6 criteria used in this study, namely: Quality, Price / cost, standardization, Service, Flexibility, On time delivery. While the alternative chosen in this problem is supplier data that has been a supplier for a long time. The supplier selected in this study is specifically for IT VSAT goods.

3.2.1 Differential analysis

The hierarchical process approach using the AHP application was applied to analyze data from the results of the questionnaire regarding the strategy for selecting suppliers of IT VSAT goods. This technique is carried out in six main steps, namely:

1. Develop AHP hirarchy diagram

Table 2 shows the six stages of the instrument in determining the supplier of IT VSAT goods.

Tabel 1. Criteria and alternatives

Criteria	Alternatives
Quality	PT. Pasific Satelit Nusantara
Price/ cost	PT. Asia Celular Satelit
Standardization	PT. Patra Telekomunikasi Indonesia
Service	PT. Infokom Elektrindo
Flexibility	PT. Mitrakom Inter Buana
On time delivery	PT. Aplikanusa Lintas Artha

2. Enter the pairwise comparison matrix data to each level for each respondent, see the Table 2.

Tabel 2. Pairwise comparison matrix for each respondent

KRITERIA	Kriteria I	Kriteria II	Kriteria III	Kriteria IV	Kriteria V	Kriteria VI
Kriteria I	1.00	a	b	c	d	e
Kriteria II	1/a	1.00	f	g	h	i
Kriteria III	1/b	1/f	1.00	j	k	l
Kriteria IV	1/c	1/g	1/j	1.00	m	n
Kriteria V	1/d	1/h	1/k	1/m	1.00	o
Kriteria VI	1/e	1/i	1/l	1/n	1/o	1.00

3. Enter the pairwise comparison matrix data based on each criterion in each alternative for each respondent, (see Table 3).

Table 3. Example of Pairwise Comparison Matrix of sub-criteria for each alternative in each respondent

Kriteria A	Alternatif I	Alternatif II	Alternatif III	Alternatif IV	Alternatif V	Alternatif VI
Alternatif I	1.00	a	b	c	d	e
Alternatif II	1/a	1.00	f	g	h	i
Alternatif III	1/b	1/f	1.00	j	k	l
Alternatif IV	1/c	1/g	1/j	1.00	m	n
Alternatif V	1/d	1/h	1/k	1/m	1.00	o
Alternatif VI	1/e	1/i	1/l	1/n	1/o	1.00

(a)

Kriteria B	Alternatif I	Alternatif II	Alternatif III	Alternatif IV	Alternatif V	Alternatif VI
Alternatif I	1.00	a	b	c	d	e
Alternatif II	1/a	1.00	f	g	h	i
Alternatif III	1/b	1/f	1.00	j	k	l
Alternatif IV	1/c	1/g	1/j	1.00	m	n
Alternatif V	1/d	1/h	1/k	1/m	1.00	o
Alternatif VI	1/e	1/i	1/l	1/n	1/o	1.00

(b)

Figure 2, shows the pairwise comparison matrix data for each level for each respondent as well as the criteria for each alternative for each respondent were entered in the AHP application using Expert Choice 2011.

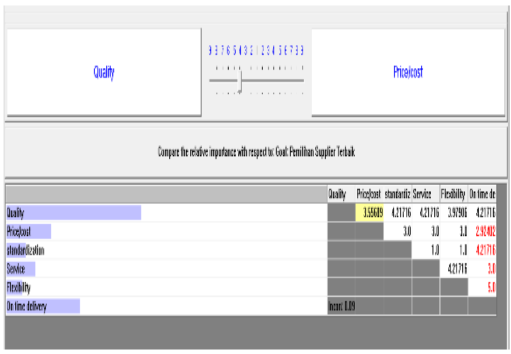

Fig. 2. An example of a matrix paired comparison of criteria with alternatives in the Expert Choice 2011 application.

To combine respondent data by selecting the Participant menu then selecting the Combine Individual button then selecting the Both button. The results can be seen in Figure 3.

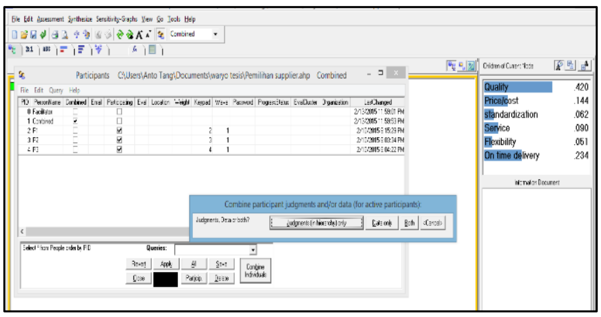

Fig. 3 The menu section on the calculation of combining respondent data

For more than one respondent, the calculations must be combined using a geometric average with the following formula (Eq. 1.):

$$\overline{X_G} = \sqrt[n]{\pi_{i=1}^{n} . X_i} \quad (1)$$

Where:

$\overline{X_G}$ = geometric mean
n = number of respondents
X_i = assessment by respondent i

4. Combined Inconsistency Value

Figure 4 shows the results of the inconsistency calculation on Expert Choice 2011.

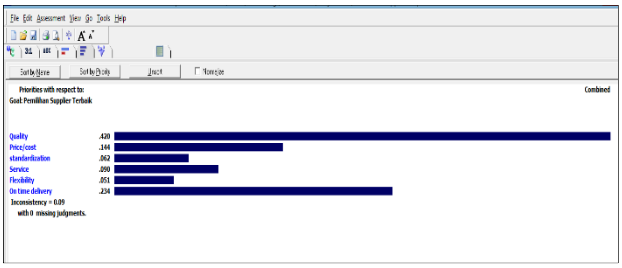

Fig. 4 Example of Inconsistency Calculation Results on Expert Choice 2011

The steps for calculating the inconsistency value and priority weight are as follows:

a. divides the value of each element in the paired matrix by the total value of each column, (see Table 4, and 5).

Tabel 4 Matrix Paired criteria with alternatives

Alternatif	Alternatif 1	Alternatif 2	Alternatif 3
Alternatif 1	1.00	0.62	2.06
Alternatif 2	1.61	1.00	2.18
Alternatif 3	0.49	0.46	1.00
Jumlah kolom	3.09	2.08	5.24

Tabel 5 Matrix normalization.

Alternatif	Alternatif 1	Alternatif 2	Alternatif 3
Alternatif 1	0.32	0.30	0.39
Alternatif 2	0.52	0.48	0.42
Alternatif 3	0.16	0.22	0.19

Ex. :

1 / 3.09 = 0.32 ; 0.62 / 2.08 = 0.30

b. Calculating Vector Eigen, Priority Weight, Synthesis Weight of each paired matrix

The eigenvector value is the weight of each element by calculating the geometric mean of each element / alternative.Untuk menghitung bobot prioritas yaitu dengan membagi nilai *eigen vektor* per elemen dengan jumlah *eigen vektor* kesuluruhan.

Synthesis weight is obtained from the number of rows in the normalized matrix and the maximum eigenvalue is obtained from the synthesis weight quotient with the priority weight per element.

Table 6. Example of eigenvector calculation results, Priorit Weights, Synthesis Weights

Alternatif	Eigen Value	Bobot prioritas	Bobot sintesis	Bobot sintesis/bobot prioritas
Alternatif 1	1.09	0.338	1.016	3.002
Alternatif 2	1.52	0.473	1.416	2.994
Alternatif 3	0.61	0.189	0.569	3.011
Jumlah	3.21		X =	9.007

c. Calculate the *Eigen Maximum* (λ max)

λ max = (x) / number of criteria

Where: (x) = the sum of (synthesis weight / priority weight).

Example:

λ max = 9.007 / 3 = 3.00

d. Test of consistency

This measurement is intended to determine the consistency of the answers which will affect the validity of the results. The formula is as follows Eq. 2.

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (2)$$

where:
CI = Deviation ratio (deviation) consistency (consistency index)
λmax = Maximum eigenvalues
n = number of criteria / elements

Example :

$$CI = \frac{\lambda_{max} - n}{n-1} = \frac{3.00 - 3}{3 - 1} = 0.00$$

If the Consistency Index is zero, the pairwise comparison matrix is consistent. The inconsistency limit set by Thomas L. using the Consistency Ratio (CR) is a comparison of the consistency index with the Random Index (RI) value found by the Oak Ridge National Laboratory, formulated as follows (Eq. 3.):

$$CR = \frac{CI}{RI} \quad (3)$$

5. Calculation of the alternative weight value for combining respondent data

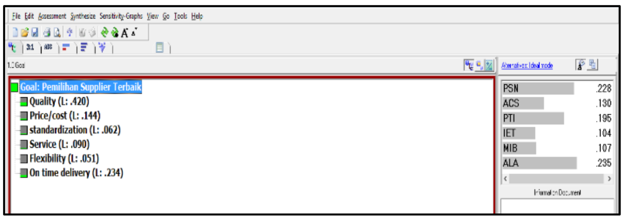

Fig. 5. Menu for calculation of alternative weights.

3.2.2. Data processing with Fuzzy-TOPSIS

Fuzzy-TOPSIS is used to make an assessment of the intangible criteria of IT VSAT suppliers so that this can be considered as a parameter to measure the fulfillment of the requirements of each supplier. Based on intangible criteria, the right supplier of IT VSAT goods can be shown by the best ranking with coefficient closeness. Following are the steps in processing data using the fuzzy-TOPSIS method:

1. Form a decision matrix.

The decision matrix D refers to m alternatives to be evaluated based on n criteria. The structure of the matrix can be described as follows.

$$D = \begin{pmatrix} 4.67 & 4.00 & 3.67 & 4.00 & 3.67 & 4.67 \\ 4.33 & 4.00 & 3.00 & 3.67 & 2.67 & 4.33 \\ 4.00 & 3.67 & 4.00 & 3.67 & 4.00 & 3.67 \\ 4.33 & 4.00 & 3.00 & 2.67 & 3.00 & 3.67 \\ 4.33 & 4.00 & 3.00 & 3.33 & 3.00 & 4.33 \\ 5.00 & 5.00 & 4.00 & 4.00 & 3.00 & 5.00 \end{pmatrix}$$

2. Normalize the decision matrix D using the following Eq. 4:

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i-j} X_{ij}^2}} \quad (4)$$

r_{ij} is the element of the normalized decision matrix R. x_{ij} xij is an element of the decision matrix X.

Where the weights are obtained from W ={ 5 5 3 4 3 5}

$$R = \begin{pmatrix} 23.35 & 20.00 & 11.01 & 16.00 & 11.01 & 23.35 \\ 21.65 & 20.00 & 09.00 & 14.68 & 08.01 & 21.65 \\ 20.00 & 18.35 & 12.00 & 14.68 & 12.00 & 18.35 \\ 21.65 & 20.00 & 09.00 & 10.68 & 09.00 & 18.35 \\ 21.65 & 20.00 & 09.00 & 13.32 & 09.00 & 21.65 \\ 25.00 & 25.00 & 12.00 & 16.00 & 09.00 & 25.00 \end{pmatrix}$$

The matrix above is obtained from multiplying the D and W matrix (weight values). After the R matrix is formed, it becomes a weighted value. From the matrix above, the weighted values are obtained as follows: where the R matrix for the first row and first column is multiplied by the D matrix, the first row of the first column is squared up to the 6 row D matrix and the 6th column R matrix and the results are in the square root, the result is as follows:

Y = (4.67*23.35)^2 + (4.00*20.00)^2 + (3.67*11.01)^2 + (4.00*16.00)^2 + (3.67*11.01)^2 + (4.67*23.35)^2
Y = 119,06
Y = SQRT(119.06) = 10.91

W = [10.91 10.12 8.51 08.78 07.97 10.55]

3. After the normalization matrix, then weighting is done to get the matrix result as below.

$$Y = \begin{pmatrix} 0.43 & 0.40 & 0.43 & 0.46 & 0.46 & 0.44 \\ 0.40 & 0.40 & 0.35 & 0.42 & 0.33 & 0.41 \\ 0.37 & 0.36 & 0.47 & 0.42 & 0.50 & 0.35 \\ 0.40 & 0.40 & 0.35 & 0.30 & 0.38 & 0.35 \\ 0.40 & 0.40 & 0.35 & 0.38 & 0.38 & 0.41 \\ 0.46 & 0.49 & 0.47 & 0.46 & 0.38 & 0.47 \end{pmatrix}$$

4. Determine the ideal solution positive and the ideal solution negative.

$$A^+ = \{(\max v_{ij} \mid j \in J), (\min v_{ij} \mid j \in J')\}$$
$$A^- = \{(\min v_{ij} \mid j \in J), (\max v_{ij} \mid j \in J')\}$$

Looking for the value A + = Max from column 1 to column 6 Looking for value A- = Min from column 1 to column 6 Then you get the following results:

	A1	A2	A3	A4	A5	A6
A+	0.46	0.49	0.47	0.46	0.50	0.47
A-	0.37	0.36	0.35	0.30	0.33	0.35

5. Calculate the separation size

$$Y = \begin{pmatrix} 0.43 & 0.40 & 0.43 & 0.46 & 0.46 & 0.44 \\ 0.40 & 0.40 & 0.35 & 0.42 & 0.33 & 0.41 \\ 0.37 & 0.36 & 0.47 & 0.42 & 0.50 & 0.35 \\ 0.40 & 0.40 & 0.35 & 0.30 & 0.38 & 0.35 \\ 0.40 & 0.40 & 0.35 & 0.38 & 0.38 & 0.41 \\ 0.46 & 0.49 & 0.47 & 0.46 & 0.38 & 0.47 \end{pmatrix}$$

	A1	A2	A3	A4	A5	A6
A+	0.46	0.49	0.47	0.46	0.50	0.47
A-	0.37	0.36	0.35	0.30	0.33	0.35

Table 8 and 9, shows the results are relative proximity and rank order of choice.

Tabel 8. Relative proximity.

Alternatif	Nilai Kedekatan
V1	0.6854
V2	0.3685
V3	0.5426
V4	0.1995
V5	0.3528
V6	0.7046

The table value above is based on the equation:

V = A- / (A+ + A-)
V = 0.2494 / (0.1145+0.2494)
V = 0.6854

Table 9. Ranking order of choice.

Variabel	Alternatif	Nilai Kedekatan	Peringkat
PSN	V1	0.6854	2
ACS	V2	0.3685	4
PTI	V3	0.5426	3
IET	V4	0.1995	6
MIB	V5	0.3528	5
ALA	V6	0.7046	1

Based on the information above, it can be seen that ALA suppliers get the highest score according to expert respondents, which is 0.7046, and in the second position there is PSN with 0.6854. in the last position, the IET supplier gets the lowest score among other suppliers, namely 0.19995.

4. CONCLUSION

From the results of this study, the following conclusions can be drawn: Assessment using the Fuzzy Multi Attribute Decision Making method is very suitable for decision making that contains quantitative data. The AHP and TOPSIS methods are considered more relevant in producing a decision than the manual method. The TOPSIS method is suitable for use in problems with complex quantitative data. The use of an appropriate method can lead to good decisions.

REFERENCES

Ahmad, N., Yaakob, A. M., Gegov, A., & Kasim, M. M. (2019). Integrating fuzzy AHP and Z-TOPSIS for supplier selection in an automotive manufacturing company. *AIP Conference Proceedings*, *2138*(August). https://doi.org/10.1063/1.5121040

Boran, F. E., Genç, S., Kurt, M., & Akay, D. (2009). A multi-criteria intuitionistic fuzzy group decision making for supplier selection with TOPSIS method. *Expert Systems with Applications*, *36*(8), 11363–11368. https://doi.org/10.1016/j.eswa.2009.03.039

Çalık, A. (2020). A novel Pythagorean fuzzy AHP and fuzzy TOPSIS methodology for green supplier selection in the Industry 4.0 era. *Soft Computing*, *9*. https://doi.org/10.1007/s00500-020-05294-9

Chopra, S., & Meindl, P. (2007). Supply Chain Management. Strategy, Planning & Operation. In *Das Summa Summarum des Management* (pp. 265–275). Wiesbaden: Gabler. https://doi.org/10.1007/978-3-8349-9320-5_22

Lourenço, H. R., & Ravetti, M. G. (2018). Supply Chain Management. In *Handbook of Heuristics* (pp. 1241–1258). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-07124-4_54

Munthafa, A., & Mubarok, H. (2017). Penerapan Metode Analytical Hierarchy Process Dalam Sistem Pendukung Keputusan Penentuan Mahasiswa Berprestasi. *Jurnal Siliwangi*, *3*(2), 192–201.

Sanayei, A., Farid Mousavi, S., & Yazdankhah, A. (2010). Group decision making process for supplier selection with VIKOR under fuzzy environment. *Expert Systems with Applications*, *37*(1), 24–30. https://doi.org/10.1016/j.eswa.2009.04.063

Sangadji, E. M. dan S. (2013). Perilaku Konsumen : Pendekatan Praktis Disertai Himpunan Jurnal Penelitian. *Penerbit Salemba*.

Shahroudi, K., & Rouydel, H. (2012). Using a multi-criteria decision making approach (ANP-TOPSIS) to evaluate suppliers in Iran's auto industry. *International Journal of Applied Operational Research Journal*, *2*(2), 37–48.

Siregar, I. (2019). Supplier Selection by Using Analytical Hierarchy Process (AHP) and Techniques for Order Preference Methods with Similarities to Ideal Solutions (TOPSIS). *Journal of Physics: Conference Series*, *1339*(1). https://doi.org/10.1088/1742-6596/1339/1/012023

Sumanto, S., & Sumarna, S. (2019). Alternatif Pemilihan Supplier Barang IT VSAT Terbaik dengan Metode Technique For Order Preference By Similarity To an Ideal Solution (TOPSIS). *J I M P - Jurnal Informatika Merdeka Pasuruan*, *4*(1), 31–36. https://doi.org/10.37438/jimp.v4i1.196

Sumanto received the Master of Computer (M. Kom) degree in Management Information System from Pascasarjana STMIK Nusa Mandiri Jakarta in 2011. His research interests include data mining and image processing.

Karlena Indriani received the Master of Computer (M. Kom) degree in Management Information System from Pascasarjana STMIK Nusa Mandiri Jakarta in 2010. His research interests include data mining and categorical data analysis.

Lita Sari Marita received the Master of Computer (M. Kom) degree in Management Information System from Pascasarjana STMIK Nusa Mandiri Jakarta in 2010. His research interests include categorical data analysis.

Ade Christian received the Master of Computer (M. Kom) degree in Management Information System from Pascasarjana STMIK Nusa Mandiri Jakarta in 2011. His research interests include categorical data analysis and networking.