icic2020_paper_223.pdf

by

Submission date: 21-Nov-2021 11:15AM (UTC+0700)
Submission ID: 1708853504
File name: icic2020_paper_223.pdf (505.29K)
Word count: 4770
Character count: 24854

Decision Support System with Fuzzy Multi-Attribute Decision Making (FMADM) and Simple Additive Weighting (SAW) In Laptop Vendor Selection

1st Anita Diana
Faculty of Information Technology
Universitas Budi Luhur
Jl. Ciledug Raya, Petukangan Utara, Jakarta, Indonesia
anita.diana@budiluhur.ac.id

2nd Achmad Solichin
Faculty of Information Technology
Universitas Budi Luhur
Jl. Ciledug Raya, Petukangan Utara, Jakarta, Indonesia
achmad.solichin@budiluhur.ac.id

***Abstract*—This study proposes Fuzzy Multi-Attribute Decision Making (FMADM) and Simple Additive Weighting (SAW) methods in developing a decision support system for selecting a laptop vendor. The problem faced is whether the FMADM process with SAW is a right and appropriate method to support selecting the best laptop vendors from existing candidates, and who is the best laptop vendor from the alternatives. So a research is needed to help management determine the right method in choosing the best laptop vendor. Another study concluded that the Fuzzy Logic method is very flexible, can create a nonlinear function model which level is very complex. FMADM is one of a method in DSS to find the best alternative from many alternative candidates with certain criteria. While the SAW method is used to find optimal alternatives with specific criteria through a weighted sum of each alternative's performance ratings, the criteria could be found in qualitative or quantitative, and some are still fuzzy. Therefore, the FMADM method with SAW was declared appropriate and right in this research. The result of this study is an application of decision support systems, and who is the best laptop vendor candidate to be chosen by management. From the User Acceptance Test (UAT) results, it can be concluded that the user strongly agrees with the decision support system application and the application of this method.**

Keywords— decision making, DSS, FMADM, SAW, laptop vendor

I. INTRODUCTION

In running the company, the hotel needs a vendor who will cooperate with the company. So the company must choose it, with a selection of various criteria that have been determined by the IT division for the selection of selected vendors. This research takes place in a hotel in Jakarta as a case study. In hotels, the selection of laptop vendors is felt to be important. This is because laptops are used for day-to-day employee and hotel operations. Almost all parts of the hotel, using a computer or laptop. The role of suppliers or vendors is significant in a company, so vendors must maintain the quality of goods so that the company's activities can run smoothly.

During this time, the IT division at the hotel using manual methods in choosing a laptop vendor. So the results can be less precise. Then the problem faced is the difficulty of choosing the right laptop vendor by the IT division. This research aims to determine the best alternative for selected laptop vendors as a supporting element in management-level decision-making. The benefit that can be obtained from this research is that it makes it easier for decision-makers to make decisions as to who the selected laptop vendors are. Another benefit is that companies have begun to use the Decision Support System as decision support for business activities.

This research is a continuation of previous study by researchers, which has discussed applying the Analytical Hierarchy Process (AHP) and the Simple Additive Weighting (SAW) method for selecting laptop vendors. From previous research that researchers did, seven criteria with their respective weights were obtained. The criteria and weights will be used in this research. Table 1 shows several studies on DSS development using FMADM and SAW methods.

TABLE I. PREVIOUS RESEARCH WITH FMADM AND SAW

No	Paper	Research Objective	Research Result
1	[1]	Major Selection at Senior High School with FMADM method.	The study results using the FMADM SAW method have accuracy values that correspond to the increase of students by 60%. And the accuracy obtained by the reality of the majors is as much as 90%.
2	[2]	Development of DSS for determining the student achievement scholarship recipients using FMADM and SAW	This study concluded that the criteria for outstanding scholarship recipients consisted of parents' income, semester, number of dependents, and GPA score. The resulting system can help determine scholarship recipients.
3	[3]	Development of a DSS for choosing the Pamong Praja member using FMADM and SAW method	This research succeeded in developing a DSS to assist the selection of the Civil Service members by applying the FMADM and SAW methods.
4	[4]	DSS To Determine Scholarship Recipients At SMAN 1 Bangunrejo Using SAW Method	This research successfully developed a DSS using FMADM and SAW method to determine the scholarship recipients.

5	[5]	Employee Placement at CV. Kencana Abadi	DSS developed in this study proved to help the process of placing new employees on the CV. Kencana Abadi. The method used is the Fuzzy SAW.
6	[6]	Development of DSS for Campus Promotion Management at a university	The FMADM and SAW method can be implemented for recommending the location of school promotion campus at Universitas Multimedia Nusantara
7	[7]	Best employee recommendation using SAW method	DSS with the SAW method is made to provide recommendation for decision makers in selecting the best employees by assessing the best performance of several candidates, but the decision maker still determines the final decision. The test results prove the quality of the DSS 81% is in the very good category..
8	[8]	Selection of the scholarship recipients at Syiah Kuala university	A DSS was developed using a numerical example to determine the scholarship recipients. The study implement Multiple Attribute Decision Making with SAW Method. The method can display a table of the sorted scholarship recipients.
9	[9]	The Selection of Periodic Salary Increment of Civil Servants using FMADM	The FMADM method selects and ranks employees according to salary increase requirements by looking at the criteria that refer to government regulations

Based on this background, we are interested in researching how to choose the best alternative laptop vendor appropriately by the IT division, in a Decision Support System to select laptop vendors. IT division is where the company has several criteria for choosing prospective vendors. These criteria can be found qualitative or quantitative, and some are still fuzzy. Therefore, we try to use the FMADM with SAW to process multi-criteria. Based on the previous study by [10], the Fuzzy-SAW way is more effectively applied than the original SAW method.

II. METHODOLOGY

A. Research Methods

In compiling this research, data and information are needed by the problem under investigation. The data and information obtained must be complete and correct enough to be used as a basis for discussing existing issues. In this research, we conducted a research method by observation, interview, literature study.

a. Observation is to collect data by direct compliance with matters relating to the decision support system to select laptop vendors.
b. Interview with the IT Manager as the person who authorized to manage the selection of laptop vendors. From interviews, the authors get data that will be used in the selection of laptop vendors.
c. The literature review by reading the current studies related to Decision Support System, Fuzzy Logic, Fuzzy Multi-Attribute Decision Making (FMADM), and Simple Additive Weighting (SAW).
d. Analyzing the bidding documents from the laptop vendor and questionnaire documents to obtain information by the system to be made.

The object of this research is the IT division at hotels in Jakarta. Where the determination of criteria and vendor selection, carried out at the division. In this research, the population is eight companies that submitted a price quote for laptops' purchase in the IT division at the hotel. In this research, we use the purposive sampling method to get data samples that we need.

Purposive sampling is a sampling technique with specific considerations. We use it technique because not all samples have criteria that fit the criteria studied. Therefore, we chose the technique that sets specific criteria that must be met by the models used in this research.

In this research, the sample is a laptop vendor company that meets specific criteria. The criteria used as research samples are:

1. The office of the laptop vendor is no more than a 10 km radius from the hotel location. It is intended to be easy for tracking and claim when there is trouble.
2. Laptop vendor companies that offer the best prices by meeting seven criteria to be used as alternatives.
3. Laptop vendor companies that are easy to contact and have no previous problems in establishing work relationships.

And it has been agreed, the sample in this research are three companies as laptop vendors, namely vendor A, vendor B, and vendor C. In this study, we used interview techniques as instrumentation and questionnaires presented in applying the FMADM and SAW method. The interviews with the IT Managers were conducted as part of determining laptop vendor selection.

B. Research Steps

Figure 1 shows our research steps. This research begins with the formulation of the problem for selecting laptop vendors by conducting observation, literature study, interviews, and document analysis, including by viewing and studying books or journal publications related to this topic. The next step is to identify the problem experienced by the decision-maker. Then fill out the questionnaire to get the required data. The next step is the collection of data, questionnaires, and documents related to the problem identified. The FMADM and SAW methods that will be examined will look at the questionnaire results and the decision-maker forms. Then analyze from data and documents collected from interviews with Decision Maker. The next step is applying the FMADM with SAW. The next phase continues with determining the alternative results of selected laptop vendors.

In this study, we also develop a DSS application that provides the laptop vendor recommendation. For the final results, we used a feedback questionnaire. This is a test of the User Acceptance Test from management, a Decision Maker as a user of this DSS application. The questionnaire is then processed, and the User Acceptance Test results are obtained from the DSS application for laptop vendor selection.

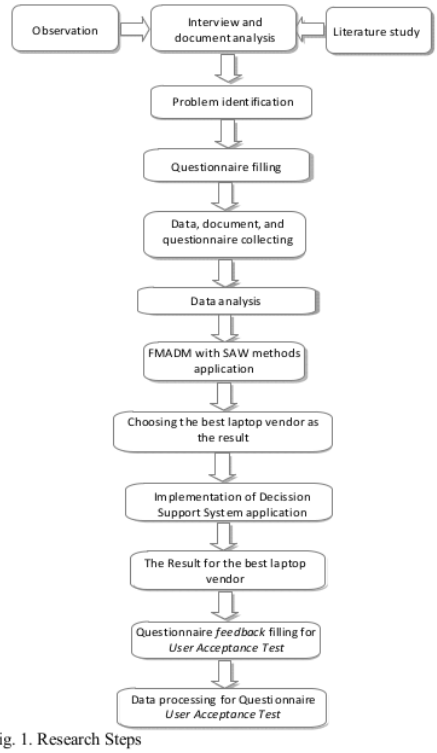

Fig. 1. Research Steps

C. Data Analysis Technique

This research used descriptive analysis and FMADM with SAW method. Descriptive analysis is done through the presentation of a summary of survey results. At the same time, FMADM with SAW method as an instrument to determine the selection of laptop vendors in the company.

Descriptive analysis is a data analysis method that tests the generalization of research results based on sample data [11]. This descriptive analysis is done by pushing the explanatory hypothesis. The results of the analysis are to provide an overview of the criteria for the predetermined requirements. In this study, descriptive analysis was carried out by presenting a summary of survey results or questionnaires distributed to decision-makers.

D. Decision Support System

The Decision Support System (DSS) is a system that can provide the ability of both the ability to solve problems and the ability to communicate to semi-structured questions. The DSS is a system that supports the decision-makers in solving semi-structured issues by providing information or proposals leading to individual decisions.

According to Turban [12] (see Figure 2), the DSS components can be built from the following subsystems:

a. Data Management Subsystem
b. Model Management Subsystem
c. User Interface Subsystem
d. Knowledge Management Subsystem

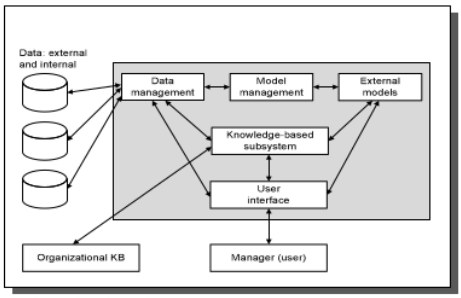

Fig. 2. Schematic View of DSS [12]

In DSS, the decision-making process must go through several phases. The decision-making process includes three main stages: intelligence, design, and choice, then Simon in 1997, adding an implementation stage. Simon's model is believed to be the most powerful and complete model of decision making. Conceptual images in the decision-making process are shown in Figure 3.

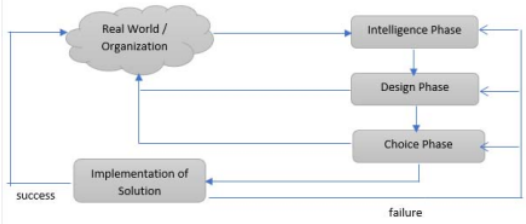

Fig. 3. Phase in Decision Making [12], [13]

E. Fuzzy Association Theory

The fuzzy method is used to represent problems that contain uncertainty in a formal language understood by computers. Prof. L. A. Zadeh [14] first introduced the fuzzy system from Berkeley in 1965. This system can develop intelligence systems in an uncertain environment. This system suspects a function with fuzzy logic.

Reasons to use Fuzzy Logic (Fuzzy Logic):

a. Logic in Fuzzy very flexible to applied
b. Logic in Fuzzy has a tolerance for inaccurate data
c. Logic in Fuzzy can model complex nonlinear functions
d. The concept of fuzzy logic is straightforward and easy to understand.
e. Fuzzy logic can build and apply experts' experiences directly without having to go through a training process.
f. Fuzzy logic can be applied with conventional control techniques easily.
g. Fuzzy logic is based on natural language.

In the fuzzy set, the membership function is the important and influential component. The membership function represents the degree of closeness of an object to specific attributes. The membership function is a curve that shows the mapping of data input into the membership value. One method that can be used to get membership values is through the function approach [15].

F. *Fuzzy Multi-Attribute Decision Making (FMADM)*

Fuzzy Multi-Attribute Decision Making (FMADM) is able to find the best alternative from several alternative candidates. FMADM will look for the weight value for each attribute, then will perform a ranking process that will select the best alternative from the alternative candidates. Based on literature studies, there are several additional methods to combine with FMADM in decision making:

a. Simple Additive Weighting (SAW) [7];
b. Weighted Product (WP) [16];
c. Elimination Et Choix Traduisant la Realite (ELECTRE);
d. The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [17];
e. Analytic Hierarchy Process (AHP) [18]

In this research, we used the Simple Additive Weighting (SAW) method to determine the ranking of alternatives to be assessed.

G. *Simple Additive Weighting (SAW)*

The Simple Additive Weighting (SAW) method is often also known as the weighted sum method. The SAW method will find the weighted sum of the performance ratings for each alternative on all attributes [12]. In the SAW method, one of the steps is the process of normalizing the decision matrix (X) to the same unit scale as all alternative candidates. Alternative assessments that have been processed for each criterion will be described in a two-dimensional matrix. The next step is the process of normalizing the alternative value data. Normalization of the alternative value i for the criterion j will be calculated using the equation formula (1). The next step after the data value has been normalized, the preference value (V) will be calculated for each alternative i using formula (2). The preference value is the multiplication of the criterion weight with the normalized value.

$$R_{ij} = \begin{cases} \dfrac{x_{ij}}{\underset{i}{Max}\, x_{ij}}, & if\ j\ is\ a\ benefit \\ \dfrac{\underset{i}{Min}\, x_{ij}}{x_{ij}}, & if\ j\ is\ cost \end{cases} \quad (1)$$

$$Vi = \sum_{j=1}^{n} (W_j R_{ij}) \quad (2)$$

Vi is the preferred value for the alternative *i*, *n* is the number of criteria, W_j is the criteria weight, and R_{ij} is the normalized value for alternative *i* and criteria *j*. A more excellent value of *Vi* indicates that alternative Ai is chosen.

The steps for solving Fuzzy MADM with SAW are:

a. Determine the value of each alternative with the fuzzy method.
b. Arrange a decision matrix based on criteria, then normalize the decision matrix. Normalize based on equations adjusted for the type of attribute, resulting in a normalized R matrix.
c. Perform calculations for the utility value vi (X) of each alternative, which is obtained from the sum of the normalized multiplication R matrix with the weight value of each criterion.
d. Perform the ranking process to get the highest score to be selected as the best alternative.

III. RESULTS AND ANALYSIS

A. *Data Processing With FMADM and SAW*

Researchers did seven criteria from previous research, and each weight was obtained in selecting laptop vendors. These criteria were obtained from interviews with IT Managers from the IT division at the hotel. After getting the specified criteria, each criterion is named C1 through C7 to facilitate the next calculation, as shown in the following table:

TABLE II. LIST OF CRITERIA

Code	Criteria	Weight
C1	Price	0,0537
C2	Support with Claim	0,4812
C3	Delivery Time	0,2525
C4	Support Pre Sales	0,1189
C5	Project Manager	0,0229
C6	Delivery Project	0,0567
C7	Good Engineer	0,0141

After getting the criteria, the weights, and alternative data, a Fuzzy Number table can be formed for each criterion. The first criteria (C1) are based on vendors' costs or prices and are converted into Fuzzy numbers, as shown in Table 3.

TABLE III. FUZZY SETS FOR CRITERIA C1

C1: Price		
Cost - Price (Rp mil)	Variable	Fuzzy Number
Cheap (Rp. 5 mil – Rp. 9 mils)	Low (L)	1
Average (Rp. 9 mil – Rp. 15 mil)	Sufficient (S)	0.5
Expensive (above Rp. 15 mils)	High (H)	0

The second criteria (C2) were based on the presence or absence of Support when warranty claims are offered from vendors, and converted into Fuzzy numbers, as shown in Table 4.

TABLE IV. FUZZY SETS FOR CRITERIA C2

C2: Support When Warranty Claims		
Support When Warranty Claims	Variable	Fuzzy Number
Not exist	Low (L)	0.5
Exist	High (H)	1

And so on applies to the same for criteria three until criteria 7.

To get data about sample assessments from vendors that will be assessed using the standard Fuzzy numbers, we distribute questionnaires filled out by decision-makers, namely IT Managers. Table 5 shows the results of analyzing the data processing of the questionnaire that we gave.

TABLE V. SAMPLE ASSESSMENT DATA TABLE

Vendor / Criteria	C1	C2	C3	C4	C5	C6	C7
Vendor A	8,890 k	Exist	On-Time	Exist	Exist	On-Time	Exist
Vendor B	9,900 k	Exist	Not on time	Not exist	Exist	Not on time	Exist
Vendor C	10,500k	Not exist	Not on time	Not exist	Exist	Not on time	Not exist

Then, from the sample data assessment results, the assessment results are transformed into Fuzzy numbers according to their respective criteria. The transformation of Fuzzy Multi-Attribute Decision Making (FMADM) can be seen in Table 6.

TABLE VI. FMADM ASSESSMENT TRANSFORMATION DATA TABLE

Vendor / Criteria	C1	C2	C3	C4	C5	C6	C7
Vendor A	1	1	1	1	1	1	1
Vendor B	0.5	1	0.5	0.5	1	0.5	1
Vendor C	0.5	0.5	0.5	0.5	1	0.5	0.5

The data processing stage will then be carried out using the SAW method to get the final results of the selected alternative vendors. To process data using the SAW method, it is necessary to determine the classification criteria first as a first step. In SAW, there are two types of criteria, namely Benefit (B) and Cost (C). Criteria are classified as Benefit (B) if the greatest value is the best. And the criteria are classified as Cost (C) if the smallest value is the best. With that basis, the seven criteria that have been obtained will be classified as seen in Table 7.

TABLE VII. CRITERIA CLASSIFICATION TABLES

CRITERIA		Classification
C1	Price	Cost
C2	Support with Claim	Benefit
C3	Delivery Time	Benefit
C4	Support Pre Sales	Benefit
C5	Project Manager	Benefit
C6	Delivery Project	Benefit
C7	Good Engineer	Benefit

The next step is to normalize the matrix obtained from the FMADM valuation transformation data table in Table 9, to calculate the value of each criterion, according to its criteria group formula. By using the steps in the SAW, the calculation steps for the alternative normalized value are carried out by the formula (1). Table 8 shows the results of the alternative normalization values.

TABLE VIII. THE NORMALIZED VALUE OF ALTERNATIVE

Vendor / Criteria	C1	C2	C3	C4	C5	C6	C7
Vendor A	0,5	1	1	1	1	1	1
Vendor B	1	1	0.5	0.5	1	0.5	1
Vendor C	1	0.5	0.5	0.5	1	0.5	0.5

The final step in finding the best vendor is to calculate the main value (V) for each alternative, where this value is the sum of the normalized alternative values multiplied by the criterion weight (see Table 2). The calculation of the principal value (V) is calculated using Equation (2). By referring to the normalized alternative value in Table 7, the main value of the alternative (V) is calculated using Equation (2) and is presented in Table 8. So, the calculation becomes:

a) **Vendor A** = {(0.0537x0.5) + (0.4812x1) + (0.2525x1) + (0.1189x1) + (0.02296x1) + (0.0567x1) + (0.0141x1)} = **0.97315**
b) Vendor B = {(0.0537x1) + (0.4812x1) + (0.2525x0.5) + (0.1189x0.5) + (0.02296x1) + (0.0567x0.5) + (0.0141x1)} = 0,78595
c) Vendor C = {(0.0537x1) + (0.4812x0.5) + (0.2525x0.5) + (0.1189x0.5) + (0.02296x1) + (0.0567x0.5) + (0.0141x0.5)} = 0.5383

After doing the above calculations, it can be concluded that **vendor A** is the best vendor with the acquisition value of **0.9463**, as shown in the Table 9.

TABLE IX. FINAL RESULTS TABLE

Vendor	Result value
Vendor A	**0,97315**
Vendor B	0,78595
Vendor C	0,5383

Although the final results have been obtained, the right to determine the selected vendor is Decision Maker, in this case, the IT Manager from the IT Division. The DSS is only as a supporting tool to accelerate and facilitate decision making. The decision maker remains the one who determines the final decision.

B. Decision Support System Applications

In this research, researchers try to develop a decision support system application to select the best laptop vendor. The report menu has a print reporting decision form and print reporting ranking form. The reporting decision form is shown in Figure 4.

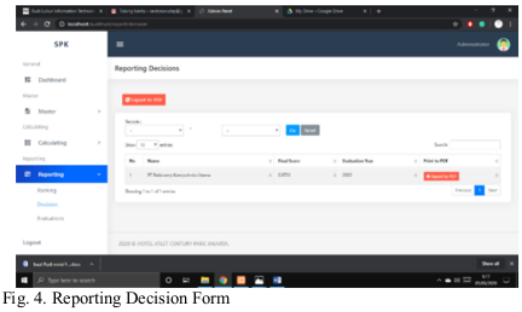

Fig. 4. Reporting Decision Form

The reporting decision form reporting ranking form are shown in Figure 5.

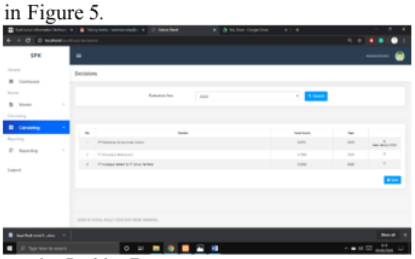

Fig. 5. Reporting Ranking Form

C. Research Result

From previous research conducted by researchers, the weight value of each criterion was obtained. The highest criteria are the current Support with Claim with a value of 0.4812. The FMADM with the SAW method can be applied appropriately and well in a Decision Support System to select laptop vendors. This is evident from the value of the final alternative results with FMADM SAW, which contrasts the results. Based on the SAW FMADM method's calculations, then from 3 (three) existing vendors, vendor A has a value of 0.97315 and is the vendor that has the highest value compared to 2 other alternatives. These contrasting results make it easy for Decision Maker to make more precise and effective decisions in choosing a laptop vendor. This means that the selected vendor in the selection of laptop vendors is vendor A.

D. Research Testing

In testing conducted by researchers through a feedback questionnaire in the form of a User Acceptance Test filled out by Decision Maker, the results are obtained that:

1) 75% strongly agree with the DSS application. The DSS applications can be operated efficiently and effectively, making it easy for users to choose a laptop vendor and provide the selected / best laptop vendor information. The selection of the data input process in the DSS application has been going well. The data storage media with a database on the DSS application helps companies manage data, and the DSS application can be a solution for decision-makers.
2) 25% agreed to the DSS application the process of calculating transactions on the DSS application is correct, and transaction data for computing on the DSS application is valid. This is because the processing and transaction data of the calculation is not the decision maker's responsibility.

But the final result in the form of the chosen alternative is not a final decision, but only as a support in making decisions. Decision Maker still acts as the final decision maker of the other options to be chosen.

IV. CONCLUSION

Based on the research of the results of data analysis that have been carried out, we can conclude some of the findings. From the calculation of the study conducted by the FMADM and SAW method. From three existing vendors, vendor A has a value of 0.97315 and is the vendor that has the highest value compared to 2 other alternatives, namely Vendor B with a number 0.78595 and Vendor C with the number 0.5383. This means that the vendor chosen in the selection of laptop vendors is vendor A. The Decision Maker agrees with these final results.

Next, based on the User Acceptance Test results, it appears that the Decision Maker strongly agrees with the existence of the DSS application to support the company in the selection of laptop vendors. This is evident from the User Acceptance Test questionnaire's value with the results of Strongly Agree with the implementation of the method. This research has proven that a Decision Support System for selecting laptop vendors with FMADM and SAM method could determine the best alternative laptop vendor appropriately by the IT division as a supporting element in management-level decision-making. A DSS also makes the process easier for decision-makers. The next research can take a greater scope and can apply with different methods.

ACKNOWLEDGMENT

Researchers give appreciation and gratitude to Universitas Budi Luhur for supporting and financing this research, and the IT Division of the Hotel to support this research.

REFERENCES

[1] F. N. Khasanah, A. E. Permanasari, and S. S. Kusumawardani, "Fuzzy Multi Attribute Decision Making for Major Selection at Senior High School," in *The 2nd International Conference on Engineering Technology and Industrial Application (ICETIA) 2015*, 2015, pp. 73–77.

[2] H. Kurniawan, A. P. Swondo, E. P. Sari, K. Ummi, Yufrizal, and F. Agustin, "Decision Support System To Determine The Student Achievement Scholarship Recipients Using Fuzzy Multiple Attribute Decision Making (FMADM) With SAW," in *The 7th International Conference on Cyber and IT Service Management (CITSM 2019)*, 2019, pp. 1–6.

[3] F. Haswan, "Decision Support System For Election Of Members Unit Patients Pamong Praja," *Int. J. Artif. Intelegence Res.*, vol. 1, no. 1, pp. 21–25, 2017.

[4] T. Susilowati, Suyono, and W. Andewi, "Decision Support System to Determine Scholarship Recipients at SMAN 1 Bangunrejo Using SAW Method," *Int. J. Inf. Syst. Comput. Sci.*, vol. 1, no. 2, pp. 29–37, 2017.

[5] I. S. Rahayu, S. Alim, and R. F. Zainal, "Decision Support System for New Employee Placement on An Office Department by Using SAW Fuzzy (Case Study: CV. Kencana Abadi)," *J. Electr. Eng. Comput. Sci.*, vol. 2, no. 2, pp. 315–318, 2017.

[6] E. Siswanto and A. W. Katili, "Implementation of Decision Support System for Campus Promotion Management using Fuzzy Multiple Analytic Decision Making (FMADM) Method," in *4th International Conference on New Media Studies*, 2017, pp. 75–80.

[7] Painem and H. Soetanto, "Decision support system with simple additive weighting for recommending best employee," *Int. Conf. Electr. Eng. Comput. Sci. Informatics*, pp. 438–441, 2019.

[8] I. Irvanizam, "Multiple attribute decision making with simple additive weighting approach for selecting the scholarship recipients at Syiah Kuala university," *Proc. - 2017 Int. Conf. Electr. Eng. Informatics Adv. Knowledge, Res. Technol. Humanit. ICELTICs 2017*, vol. 2018-January, no. ICELTICs 2017, pp. 245–250, 2017.

[9] W. E. Sari and S. Fauziati, "The Selection of Periodic Salary Increment of Civil Servants using Fuzzy MADM," in *2019 4th International Conference on Information Technology, Information Systems and Electrical Engineering (ICITISEE)*, 2019, pp. 51–56.

[10] P. Lestari, T. Prabowo, and W. Utomo, "The Effectiveness of Fuzzy-SAW Method for the Selection of New Student Admissions in Vocational High School," *Lett. Inf. Technol. Educ.*, vol. 3, no. 1, pp. 18–22, 2020.

[11] Y. Agusyana, *Olah data skripsi dan penelitian dengan SPSS 19*. Jakarta: Elex Media Komputindo, 2011.

[12] E. Turban, J. E. Aronson, and T.-P. Liang, "Decision Support Systems and Business Intelligence," *Decis. Support Bus. Intell. Syst. 7/E*, pp. 1–35, 2007.

[13] I. Markovic, "Decision-Making Process," *Medium.com*, 2018. [Online]. Available: https://medium.com/unitfly/decision-making-process-4648a6cd827d. [Accessed: 02-Feb-2020].

[14] L. a. Zadeh, "Fuzzy sets," *Inf. Control*, vol. 8, no. 3, pp. 338–353, 1965.

[15] S. Kusumadewi, S. Hartati, A. Harjoko, and R. Wardoyo, *Fuzzy Multi-Attribute Decision Making*. GRAHA ILMU, 2006.

[16] D. M. Khairina, M. R. Asrian, and H. R. Hatta, "Decision Support System For New Employee Recruitment Using Weighted Product Method," in *2016 3rd International Conference on Information*

Technology, Computer, and Electrical Engineering (ICITACEE), 2016, pp. 297–301.

[17] K. Bunajjar and A. Solichin, "Determining the Location of a Wholesale Pulse Business Branch with ANP and TOPSIS Methods," *Int. J. Adv. Stud. Comput. Sci. Eng.*, vol. 7, no. 11, pp. 1–5, 2018.

[18] R. E. Sari, A. Meizar, D. H. Tanjung, and A. Y. Nugroho, "Decision making with AHP for selection of employee," in *2017 5th International Conference on Cyber and IT Service Management (CITSM)*, 2017, pp. 1–5.

icic2020_paper_223.pdf

ORIGINALITY REPORT

10%	9%	10%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	journal.portalgaruda.org Internet Source	3%
2	Aulia Ishak, Wanli. "Evaluation and Selection of E-commerce Service Quality Using Fuzzy AHP Method", IOP Conference Series: Materials Science and Engineering, 2020 Publication	2%
3	ojs.stmikpringsewu.ac.id Internet Source	1%
4	Marsujitullah, Rachmat, Agus Prayitno, M Y Zamhuri. "Decision support system determination of acceptance of employees not civilian state employees (PBPNS) in LPP RRI Merauke using simple additive weighting method", IOP Conference Series: Earth and Environmental Science, 2019 Publication	1%
5	jurnal.polgan.ac.id Internet Source	1%
6	publikasiilmiah.ums.ac.id Internet Source	1%

7	Sari Wahyuni Eka, Fauziati Silmi. "The Selection of Periodic Salary Increment of Civil Servants using Fuzzy MADM", 2019 4th International Conference on Information Technology, Information Systems and Electrical Engineering (ICITISEE), 2019 Publication	1 %
8	Helmi Kurniawan, Ashari P Swondo, Eka Purnama Sari, Khairul Ummi, Yufrizal, Fhery Agustin. "Decision Support System To Determine The Student Achievement Scholarship Recipients Using Fuzzy Multiple Attribute Decision Making (FMADM) With SAW", 2019 7th International Conference on Cyber and IT Service Management (CITSM), 2019 Publication	1 %
9	Irvanizam Irvanizam. "Multiple attribute decision making with simple additive weighting approach for selecting the scholarship recipients at Syiah Kuala university", 2017 International Conference on Electrical Engineering and Informatics (ICELTICs), 2017 Publication	1 %

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		