DECISION SUPPORT SYSTEM FOR PURCHASING SPEAKER MONITOR HOME RECORDING USING FUZZY MULTIPLE ATTRIBUTE DECISION MAKING

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ABSTRACT

Technological developments in the field of music are currently experiencing progress, including the formation of computer-based recording, namely the Digital Audio Workstation (DAW). Monitor speakers are one of the most important components of a DAW. A good selection of monitor speakers can support the quality of sound produced by a home recording or recording service provider. The many variations and specifications of monitor speakers on the market make it difficult for users to choose based on four criteria: price, response frequency, design criteria, and power output. So it is necessary to make an application that can determine recommendations for purchasing monitor speakers by applying the Fuzzy Multiple Attribute Decision Making Algorithm. The results obtained in this study show that of the five alternative monitor speakers, KRK ROKIT G4 5 has the highest alternative preference rating of 2.2,5 so it can be used as a reference monitor speaker for home recording.

Keywords: *Digital audio workstation, FMADM, decision support system, monitor speaker, home recording*

1. INTRODUCTION

The development of communication technology today is progressing. One of the developments that occurred in the field of music was the formation of computer-based recording, namely the Digital Audio Workstation (DAW). DAW is a digital recording system that uses a computer device [1]. Monitor speakers are an essential component of a DAW, besides being supported by computers, DAW software, audio interfaces, midi controllers, and microphones. The selection of good monitor speakers can improve the quality of sound produced at home by recording or recording service providers. With the existence of the DAW, technology that was originally analog has now gone digital. Besides being used for the recording process, DAW's can also be used for mixing and mastering. Any function in an analog recorder can be applied to a DAW. Even with the presence of a DAW, it is easier to produce digital music and get satisfactory results with digital recorders. The selection of speakers manually based on the expected criteria is quite difficult because of the many variations in the market. So it is necessary to have a decision support system to help make the best choice based on the criteria desired by the user.

In this study, a decision support system uses four criteria: price, response frequency, design, and power output. Applying the Fuzzy Multiple Attribute Decision Making (FMADM) algorithm method. In this method, the system looks for optimal alternatives from several alternatives with certain criteria. The Simple Additive Weighting (SAW) method is known as the weighted sum. The essence of SAW is looking for a weighted sum of performance ratings for each alternative on all attributes. The FMADM method was chosen for the decision support system in this case because it can solve problems precisely and efficiently and is easier to implement than other methods [2]. The result of this decision support system is in the form of a monitor speaker ranking table that has been selected based on the weight of the criteria entered by the user.

Research conducted by Lismardiana in 2018 stated that applying the Fuzzy Multiple Attribute Decision Making and SAW models could facilitate the selection of the best graduates. The SAW method was chosen because it is better

at calculating the weight of scores on each decision support attribute so as to produce accurate and more efficient calculations in its process for determining outstanding students [3].

In addition, similar research has also been conducted by Pajarini in 2018, who stated that the system created aims to determine students who are entitled to get scholarships using the SAW method and Fuzzy Multiple Attribute Decision Making. The SAW method is used for ranking the existing alternatives. The Fuzzy Multiple Decision Making (FMADM) method is used to find alternatives from several alternatives with predetermined criteria. The results of the research can function as a decision support system to determine which students are truly eligible to receive scholarships [4].

Research on decision support systems using FMADM has also been carried out by Ibnu and Fristi to choose an Android cellphone, they uses five criteria, including processor speed, hard drive, memory, VGA, and price. Based on the results of the tests that have been carried out, changes in the value of the criteria and the number of alternatives are very influential on the results of alternative ideal solutions obtained [5].

Decision support systems with the FMADM method have also been used for research by Dicki, Renny, and Achmad to determine the tools for effective promotion of a wedding organizer's business services. In this study, 5 criteria were used, namely Canvassing, Online Social Media, Internal Marketing, Marcomm Development, and Offline Show. The use of this method is divided into three parts: position matrix projection, projection ranking, and aggregation of global rankings. The results of the final calculation show that online social media criteria are ranked first, which can be done next to be selected as a sales priority [6].

2. BACKGROUND THEORY

2.1 Decision Support Systems (DSS)

Decision Support System is a computer-based system that can assist in the decision-making process. The decision support system was developed to find a way out of unstructured management problems as an adaptive, interactive, and flexible system to improve the quality of decision-making. Conclusions can be drawn regarding the definition of a Decision Support System, namely a computer-based system that is adaptive, interactive, and flexible for solving unstructured problems, thereby increasing the quality of decisions taken [7].

Decision Support System (DSS) can be defined as a system that can provide both problem-solving abilities and semi-structured problem communication skills. Specifically, a Decision Support System is defined as a system that supports managers in making decisions by solving problems by providing data or suggestions that lead to certain decisions.

Decision-making is the main task of a manager or administrator. Decision-making activities include problem analysis, finding alternatives to problems, evaluating these alternatives, and selecting alternatives to make the best decision. To make the best decisions, a manager must know the theory and techniques of decision making. Making the best decision will certainly increase the productivity and work efficiency of the manager [8].

2.1.1 Advantages of Using Decision Support Systems

The following are some of the advantages of using a decision support system.

a. Able to support the selection of solutions to various complex problems.
b. Can respond quickly to unwanted situations in dynamic conditions.
c. Able to apply various strategies to different configurations quickly and precisely.
d. New views and knowledge.
e. As a facilitator in communication.

2.2 Monitor Studio Speakers

The equipment needed to build a recording studio varies, one of which is near-field studio monitors, better known as flat speakers or monitor speakers. This speaker is called a near-field monitor because it is used at close range to the engineer's ear.

There are many monitor speakers on the market with varying sizes and prices for professional recording studios, home recording, mixing to mastering. Unlike speakers in general that are used for home theater, hi-fi systems, or computers, monitor speakers can produce sound with a flat frequency because they are specially designed and have advantages in producing sound. Monitor speakers, or near-field monitors, have the following advantages:

a. Able to minimize suppression or de-emphasis (pressure), which means there is no shift in phrase shift from a certain frequency so that the frequency issued by the monitor speaker is accurate.
b. Capable of producing accurate tone quality from the original audio source.
c. Be Able to respond to frequencies in a wide range so that instruments that have been recorded will sound clear and detailed.

2.3 Fuzzy Multiple Attribute Decision Making (FMADM)

FMADM is a method for drawing optimal alternatives from a number of alternatives with certain criteria by determining the weight value for each attribute, then proceeding with a ranking process that will choose or select the alternatives that have been given. There are three approaches to finding attribute weight values: the subjective approach, the objective approach, and the integrated approach between subjective and objective. In the subjective approach, the weight values are determined based on the subjectivity of the decision-makers, so several factors in the alternative ranking process can be determined freely. Whereas in the objective approach, the weight value is calculated mathematically so that it ignores the subjectivity of the decision-maker[9].

Basically, the FMADM process is carried out through three stages: the preparation of situation components, analysis, and synthesis of information. At the stage of compiling the components, and situation components, an estimation table will be formed that contains an identification of alternatives and specifications of objectives, criteria, and attributes. One of the steps to specifying the objective of the situation is to list the possible consequences of the identified alternatives. In addition, the attributes will be organized for use [10].

Stages of analysis are carried out in two steps. First, it derives estimates of the potential magnitudes, probabilities, and uncertainties associated with the possible impacts of each alternative. The second includes the selection of the decision maker's preferences for each value and indifference to the risks that arise. In the first step, some methods use a distribution function that expresses the probability of a set of attributes against alternatives. Consequences can also be determined directly from simple aggregations performed on the best available information. Some of the common features used by FMADM.

a. Alternatives are different objects that have the same opportunity to be selected by the decision maker.
b. Attributes are often also referred to as characteristics, components, or decision criteria. Although most of the criteria are one-level, it does not rule out the possibility that there are sub-criteria related to the criteria that have been given.
c. Conflict between criteria: several criteria usually have conflicts with one another; for example, the profit criteria will conflict with the cost criteria.
d. Decision weight shows the relative importance of each criterion, W = (W1, W2, ..., Wn). In MADM, the importance weight of each criterion will be sought.
e. The decision matrix, a decision matrix X with size m x n, contains elements of Xij, which represent the rating of alternative Ai (i=1,2,..,m) against criterion Cj (j=1,2,...,n).

The FMADM problem is evaluating m alternatives Ai (i=1,2,...,m) against a set of attributes or criteria Cj (j=1,2,...,n), where each attribute is independent of one other. The criteria or attributes can be divided into two categories:

a. Benefit criteria are criteria whose value will be maximized, for example, gain, Frequency Response (in the case of selecting monitor speakers for home recording).
b. Cost criteria are criteria whose value will be minimized, for example, the price of speakers to be selected.

In FMADM, the decision matrix for each alternative to each attribute, X, is given as.

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix}$$

Information:
X = Performance Rating
Xm = Alternative Performance Rating
Xn = Criterion Performance Rating
With Xij is the performance rating of the i-th alternative to the j-th attribute. The weight value, which indicates the relative importance of each attribute, is given as, W.

$$W = \{W_1, W_2, \dots, W_n\}$$

Information:
W = Weight value
W1 = Weight value 1
W2 = Weight value 2
Wn = Criteria weight value

Performance ratings (X) and weight values (W) are the main values that represent the absolute preferences of decision-makers. The FMADM problem ends with a ranking process to get the best alternative based on the overall value of the preferences given. In FMADM, generally will find the ideal solution. Which is the ideal solution that will maximize the profit criteria and minimize all cost criteria.

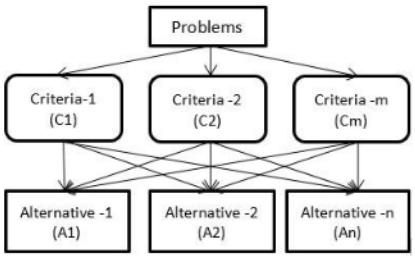

Figure 1. The MADM structure

The FMADM structure in Figure 1 can be explained as follows. When the problem has been identified, it is necessary to establish criteria for selecting alternatives. Each alternative has the same criteria as those determined earlier.

2.4 Simple Additive Weighting Method (SAW)

SAW is often also known as the weighted sum method. The basic concept of the SAW method is to find the weighted sum of the performance ratings for each alternative on all attributes. The SAW method requires a process of normalizing the decision matrix (X) to a scale that can be compared with all existing alternative ratings. Preference value for each alternative (Vi). (Wahyuningsih, 2015).

$$Vi = \sum_{j=1}^{n} Wj\ rij \quad (1)$$

Information: Vi = alternative, Wj = weight value of each criterion, Rij = normalized performance rating value. The normalized performance rating value can be formulated as below.

$$rij = \begin{cases} \frac{Xij}{Max\ Xij} \\ \\ \frac{Min\ Xij}{Xij} \end{cases} \quad (2)$$

Xij is the rating of the alternative. A larger value of Vi indicates that the alternative Ai (i = 1,2,...,m) is more selected.

3. SYSTEM DESIGN METHOD

The system design method used is the Unified Modeling Language (UML) method which consists of use case diagrams, activity diagrams, sequence diagrams, class diagrams, and table relations.

The use case diagram in Figure 2 can be explained as follows.All tasks carried out by the admin must go through login. Users can edit criteria, manage alternative data, manage weighting value data, and process results.

Class diagrams are an overview of the structure of the system in terms of defining the classes that will be created to create a system. Classes have attributes and methods or operations. Attributes are variables that are owned by a class. Operations or methods are functions that belong to an object.

In the class diagram for purchasing a monitor speaker for home recording in Figure 3 can be explained that each criteria table and monitor speaker table are related to the table of values, while the results table has no relationship because the results table is used to temporarily store the results of the calculation. Activity diagrams describe the workflow or activity of a system. Activity diagrams describe system activity, not what actors do.

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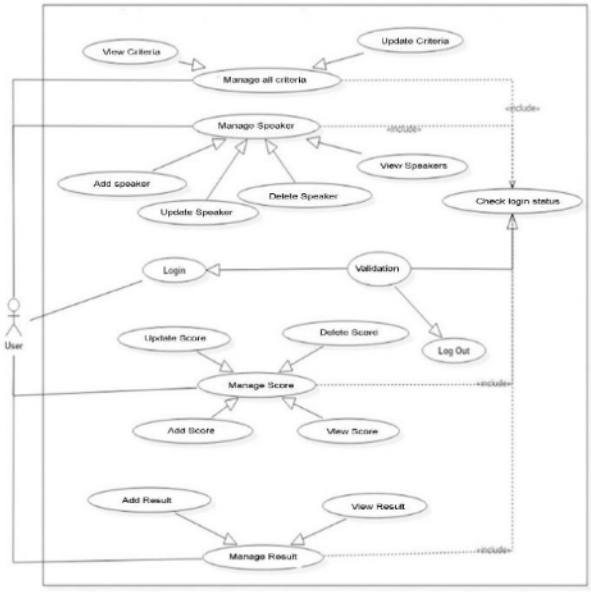

Figure 2. Use case diagrams

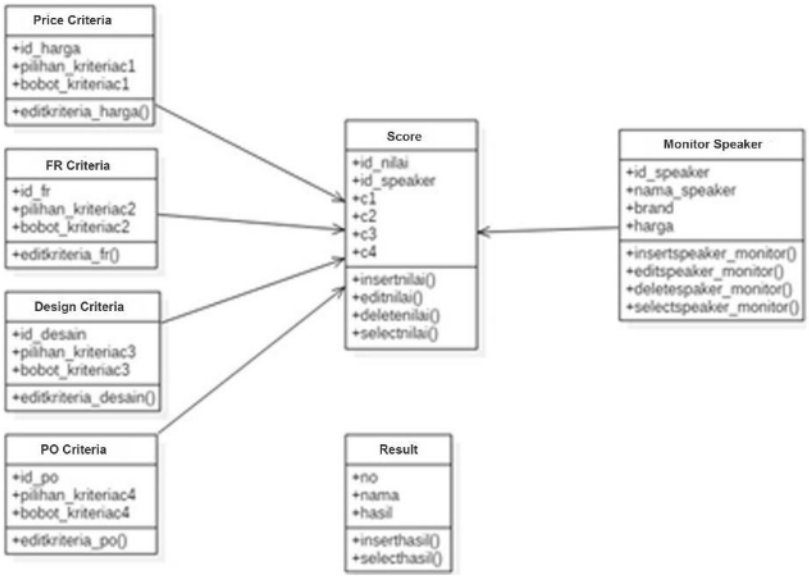

Figure 3. Class Diagram DSS Pembelian Speaker Monitor

4. RESULT AND DISCUSSION

The application of the FMADM method in this study requires weights and criteria to determine which alternatives will be selected as scholarship recipients. The criteria are as follows. C1 = Price, C2 = Frequency Response, C3 = Design, and C4 = Power Output. From each of these weights, a variable is created. Where a variable is converted into fuzzy numbers. Below is the fuzzy number of the weight. Very Good (SB), Good (B), Medium (S), Less (K), and Very Less (SK). To get these variables in a graph so that it is clearer, the weight graph can be seen in Figure 4.

Price Criteria Table (C1) is a table that contains criteria for speaker price ranges. The weights are determined based on fuzzy numbers, namely 0 to 1. The price criteria table can be seen in Table 1.

The Frequency Response Criteria Table (C2) is a table that contains the criteria for the response frequency range. The weights are determined based on fuzzy numbers, namely 0 to 1. The table of Response Frequency Criteria can be seen in Table 2.

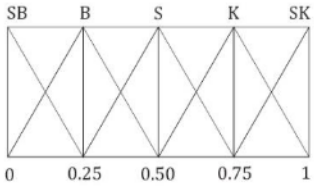

Figure 4. Weight Chart

Table 1. Monitor Speaker Price Criteria

Criteria Selection	Weight
3.000.000 - 3.500.000	1
3.500.000 - 4.000.00000	0,75
4.000.000 - 4.500.000	0,5
4.500.000 - 5.000.000	0,25
5.000.000 - 5.500.000	0

Table 2. Response frequency criteria

Criteria Selection	Weight
43 Hz - 40 kHz	1
54 Hz - 30 kHz	0,75
60 Hz - 40 kHz	0,5
50 Hz - 27 kHz	0,25

Table 3. Design Criteria

Criteria Selection	Weight
Very Good	1
Good	0,75
Medium	0,5
Less	0,25
Very Less	0

Table of Design Criteria (C3) is a table containing design criteria. The weights are determined based on fuzzy numbers, namely 0 to 1. The design criteria table can be seen in the table 3.

The Power Output Criteria Table (C4) is a table that contains the Power Output criteria. The weights are determined based on fuzzy numbers, namely 0 to 1. The table of Power Output Criteria can be seen in Table 4.

The Alternative table contains the alternatives included in the spk assessment. This table has parameters of speaker series, brand, and price. An alternative table can be seen in Table 5.

Table 4. Power Output Criteria

Criteria Selection	Weight
100 W	1
70 W	0,75
55 W	0,5
50 W	0,25
40 W	0

Table 5. Alternative

Speaker Series	Brand	Price
KRK Rokit G4 5 Inch	KRK	4500000
Yamaha HS 5	Yamaha	3200000
M-Audio BX5D3	M-Audio	4050000
Samson se5	Samson	3250000
Mackie CR5BT	Mackie	3350000

Table 6. Rating

Ai	Criteria				
	Speaker	Price	Response frequency	Design	Power Output
A1	KRK ROKIT G4 5"	4500000	43Hz-40KHz	Very Good	55 W
A2	Yamaha HS 5	3200000	54Hz-30kHz	Good	70 W
A3	M-Audio BX5D3	4050000	60Hz-40kHz	Medium	100 W
A4	Samson se5	3250000	50Hz-27kHz	Less	70 W
A5	Mackie CR5BT	3350000	60Hz-20kHz	Very Less	50 W

Table 7. Match Rating of Each Alternative on Each Criterion

Ai	C1	C2	C3	C4
A1	0,25	1,00	1,00	0,50
A2	1,00	0,75	0,75	0,75
A3	0,50	0,50	0,50	1,00
A4	1,00	0,25	0,25	0,75
A5	1,00	0,25	0,25	0,25

The rating table is a table that contains the speaker's name and the value of the alternative which will later be used as a suitability rating table according to a predetermined weighting. Assessment data can be seen in table 6.

From the rating table, a compatibility rating table for each alternative for each criterion can be made, can be seen in table 7.

The following are the steps for completing the calculation :

1) Weight vector : W= [0.25, 1, 0.75, 0.50]
2) Calculating the x decision matrix based on weight criteria.

$$X = \begin{bmatrix} 0.25 & 1.00 & 1.00 & 0.50 \\ 1.00 & 0.75 & 0.75 & 0.75 \\ 0.50 & 0.50 & 0.50 & 1.00 \\ 1.00 & 0.25 & 0.25 & 0.75 \\ 1.00 & 0.00 & 0.25 & 0.25 \end{bmatrix}$$

3) Normalization of the X matrix.

Alternative A1

$$r11 = \frac{Min\ (0.25,1.00,0.50,1.00,1.00)}{0.25} = 1.00$$

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$$r12 = \frac{Min\ (0.25,1.00,0.50,1.00,1.00)}{1.00} = 0.25$$

$$r13 = \frac{Min\ (0.25,1.00,0.50,1.00,1.00)}{0.50} = 0.50$$

$$r14 = \frac{Min\ (0.25,1.00,0.50,1.00,1.00)}{1.00} = 0.25$$

$$r15 = \frac{Min\ (0.25,1.00,0.50,1.00,1.00)}{1.00} = 0.25$$

Alternative A2

$$r21 = \frac{1.00}{Max\ (1.00,0.75,0.50,0.25,0.00)} = 1.00$$

$$r22 = \frac{0.75}{Max\ (1.00,0.75,0.50,0.25,0.00)} = 0.75$$

$$r23 = \frac{0.50}{Max\ (1.00,0.75,0.50,0.25,0.00)} = 0.50$$

$$r24 = \frac{0.25}{Max\ (1.00,0.75,0.50,0.25,0.00)} = 0.25$$

$$r25 = \frac{0.00}{Max\ (1.00,0.75,0.50,0.25,0.00)} = 0.00$$

Alternative A3

$$r31 = \frac{1.00}{Max\ (1.00,0.75,0.50,0.25,0.25)} = 1.00$$

$$r32 = \frac{0.75}{Max\ (1.00,0.75,0.50,0.25,0.25)} = 0.75$$

$$r33 = \frac{0.50}{Max\ (1.00,0.75,0.50,0.25,0.25)} = 0.50$$

$$r34 = \frac{0.25}{Max\ (1.00,0.75,0.50,0.25,0.25)} = 0.25$$

$$r35 = \frac{0.25}{Max\ (1.00,0.75,0.50,0.25,0.25)} = 0.25$$

Alternative A4

$$r41 = \frac{0.50}{Max\ (0.50,0.75,1.00,0.75,0.25)} = 0.50$$

$$r42 = \frac{0.75}{Max\ (0.50,0.75,1.00,0.75,0.25)} = 0.75$$

$$r43 = \frac{1.00}{Max\ (0.50,0.75,1.00,0.75,0.25)} = 1.00$$

$$r44 = \frac{0.75}{Max\ (0.50,0.75,1.00,0.75,0.25)} = 0.75$$

$$r45 = \frac{0.25}{Max\ (0.50,0.75,1.00,0.75,0.25)} = 0.25$$

From the results of the calculation above, the normalized matrix R is obtained as follows:

$$R = \begin{bmatrix} 1.00 & 1.00 & 1.00 & 0.50 \\ 0.25 & 0.75 & 0.75 & 0.75 \\ 0.50 & 0.50 & 0.50 & 1.00 \\ 0.25 & 0.25 & 0.25 & 0.75 \\ 0.25 & 0.00 & 0.25 & 0.25 \end{bmatrix}$$

4) Finding the best alternative, using equation (1)

V1= (1.00 X 0.25)+(1.00 X 1.00)+(1.00 X 0.75)+(0.50 X 0.50) = 2.25
V2= (0.25 X 0.25)+(0.75 X 1.00)+(0.75 X 0.75)+(0.75 X 0.50) = 1.75
V3= (0.50 X 0.25)+(0.50 X 1.00)+(0.50 X 0.75)+(1.00 X 0.50) = 1.50
V4= (0.25 X 0.25)+(0.25 X 1.00)+(0.25 X 0.75)+(0.75 X 0.50) = 0.88
V5= (0.25 X 0.25)+(0.00 X 1.00)+(0.25 X 0.75)+(0.25 X 0.50) = 0.38

V1 is ranked first because it has a greater value than other values, v1 is the preferred value of alternative a1, so a1 or in this case, krk rokit g4 5" is the best alternative.

(1)

4. CONCLUSION AND SUGGESTION

4.1 Conclusion

Based on the research that has been done, it can be concluded as follows.

1) The application is a decision support system for selecting monitor speakers for home recording using fuzzy multiple attribute decision making with simple additive weighting.
2) The user can input the appropriate alternatives to be compared, there is no limit to the number. However, for the criteria, the user can only change the description and weight and cannot add or delete items. The number of criteria attributes has been set, which amounts to five attributes.
3) For the DSS calculation process, the data will be temporarily stored in the database and will be overwritten by the new calculation data if the user selects the DSS value process page.

4.2 Suggestion

Based on the research conclusions, the suggestions given are as follows.

1) For further research, other methods can be used to find out how efficient the method being used is compared to the research that has been done.
2) Can add more than four criteria data.

REFRENCES

[1] A. T. B. Abdulah, (2018), *Adopsi Teknologi Digital Audio Workstation Dengan Pendekatan Difusi Inovasi*, Universitas Muhammadiyah Surakarta.

[2] R. Aprilia, D. J. Panjaitan, and H. P. Rollingka, (2022), *Determination of Food Menu in Obesity Patients with the Fuzzy Multiple Attribute Decision Making Method*, *G-Tech*, vol. 6, no. 2, pp. 360–367, doi: 10.33379/gtech.v6i2.1761.

P-ISSN: 2528-0260 E-ISSN: 2579-5392
p.9-18

[3] Lismardiana, (2018), *Fuzzy Multi-Atribute Decision Making (Fuzzy Madm) Dengan Metode Saw Dalam Penentuan Lulusan Mahasiswa Berprestasi*, Jurnal Teknologi Informasi dan Komunikasi, vol. 7, no. 1.

[4] F. Yani, Y. Yuranda, P. Pajarini, and R. Rosmawati, (2018), *Penentuan Beasiswa pada SMPN 6 Pangkalpinang Menggunakan Metode SAW dan Fuzzy Multi Attribute Decision Making*, Jurnal Rekayasa Sistem dan Teknologi Informasi, vol. 2, no. 1, doi: 10.29207/resti.v2i1.325.

[5] I. Rizky and F. Riandari, (2020), *Decision Support System for HP Android Selection Using FMADM Model (Fuzzy Multiple Attribute Decision Making) with Weight Product (WP) Method*, Login, vol. 14, no. 2, pp. 374–383.

[6] D. Prayudi, R. Oktapiani, and A. A. Gunawan, (2021), *Keputusan Promosi Efektif dengan Metode Oreste Fuzzy Multiple Attribute Decision Making (FMADM) pada UMKM Gosimplywedding Sukabumi*, Jurnal Informatika Universitas Pamulang, vol. 6, no. 2, pp. 290–296, doi: 10.32493/informatika.v6i2.9855.

[7] M. Megawaty and M. Ulfa, (2020), *Decision Support System Methods: A Review*, Journal of Information Systems and Informatics, vol. 2, no. 1, pp. 192–201, doi: 10.33557/journalisi.v2i1.63.

[8] O. Okfalisa, H. Rusnedy, D. U. Iswavigra, B. Pranggono, E. Haerani, and T. Saktioto, (2021), *Decision Support System For Smartphone Recommendation: The Comparison Of Fuzzy Ahp And Fuzzy Anp In Multi-Attribute Decision Making*, SINERGI, vol. 25, no. 1, pp. 101–110, doi: 10.22441/sinergi.2021.1.013.

[9] M. A. P. Pratama, A. Sukmaaji, and V. Nurcahyawati, (2022), *Perancangan User Interface (Ui)/User Experience(Ux) E-Commerce Menggunakan Metode Lean Ux Dan User Experinxe Questionnaire (Ueq) Pada Ijoe Biru Clothing Untuk Meningkatkan Experience Pemesanan Custom Produk Dan Pembelian Produk*, Jurnal Sistem informasi dan Komputer Akuntansi, vol. 11, no. 2, pp. 95–101.

[10] B. V. Christioko, H. Indriyawati, and N. Hidayati, (2017), *Fuzzy Multi-atribute Decision Making (Fuzzy Madm) Dengan Metode Saw Untuk Pemilihan Mahasiswa Berprestasi*, Jurnal Transformatika Universitas Semarang, vol. 14, no. 2, pp. 82–85, doi: 10.26623/transformatika.v14i2.441.