# Weighting Comparative Analysis Using Fuzzy Logic and Rank Order Centroid (ROC) in the Simple Additive Weighting (SAW) Method

**Alfin Ghazali[1*], Poltak Sihombing[2], Muhammad zarlis [3]** iD

*[1,2,3] Magister Teknik Informatika, Universitas Sumatera Utara, Indonesia*
*\*Corresponding author:* alfinghazali20@gail.com

## *Abstrak*

*Wabah Covid-19 telah mengubah sistem pembelajaran di Indonesia menjadi pembelajaran jarak jauh atau yang lebih dikenal dengan pembelajaran online. Dalam menentukan hasil belajar siswa terhadap kepuasan belajar siswa terhadap pembelajaran jarak jauh di masa pandemi Covid-19, maka dilakukan penelitian menggunakan Metode Simple Additive Weighting (SAW). Penelitian ini bertujuan untuk mengetahui bagaimana hasil belajar siswa di masa pandemi Covid-19. Jenis penelitian yang digunakan dalam penelitian ini adalah penelitian terapan, yang mana penelitian ini diarahkan untuk mendapatkan informasi yang dapat digunakan untuk memecahkan masalah. Metode yang digunakan adalah Simple Additive Weighting (SAW) dengan membandingkan hasil keputusan metode SAW antara pembobotan berdasarkan metode Fuzzy Logic dengan pembobotan berdasarkan metode ROC. Subjek yang terlibat dalam penelitian ini yakni siswa Sekolah Menengah Kejuruan (SMK) yang berjumlah 36 orang. Pengumpulan data dalam penelitian dilakukan dengan menggunakan metode pengamatan langsung, wawancara dan kuesioner. Kriteria yang terdapat pada kuesioner merupakan faktor yang mempengaruhi proses hasil belajar siswa terhadap kepuasan belajar di masa pandemi Covid-19. Adapun kriteria yang digunakan adalah kepemilikan perangkat, aksebilitas, kemudahan memperoleh materi, ketepatan metode, kemampuan memantau, interaktivitas, dan kemandirian belajar. Dari ketujuh kriteria tersebut maka ditentukan skala prioritasnya. Hasil penelitian menunjukkan bahwa analisis pencarian nilai bobot metode Simple Additve Weighting (SAW) secara Fuzzy Logic dan Simple Additve Weighting (SAW) dengan menggunakan perhitungan metode Rank Order Centroid (ROC) menghasilkan nilai bobot kriteria subkriteria yang berbeda, sehingga dapat dikatakan bahwa kombinasi SAW-ROC memberikan penyeleksian terhadap penentuan jumlah siswa lebih akurat dan lebih selektif.*

*Keywords: Fuzzy Logic, Pembobotan , Rank Oerder Centroid, Simple Additive Weighting*

## Abstract

The Covid-19 outbreak has changed the learning system in Indonesia into distance learning, better known as online learning. In determining student learning outcomes on student learning satisfaction with distance learning during the Covid-19 pandemic, a study was carried out using the Simple Additive Weighting (SAW) method. This study aims to determine student learning outcomes during the Covid-19 pandemic. The type of research used in this research is applied research, in which this research is directed to obtain information that can be used to solve problems. The method used is Simple Additive Weighting (SAW) by comparing the results of the decision of the SAW method between the weighting based on the Fuzzy Logic method and the weighting based on the ROC method. The subjects involved in this study were 36 students of Vocational High School (SMK). Data collection in the study was carried out using direct observation, interviews, and questionnaires. The criteria contained in the questionnaire are factors that affect the process of student learning outcomes on learning satisfaction during the Covid-19 pandemic. The criteria used are device ownership, accessibility, ease of obtaining materials, method accuracy, monitoring ability, interactivity, and independent learning. From the seven criteria, the priority scale is determined. The results showed that the analysis of the search for weight scores using the Simple Additive Weighting (SAW) method using Fuzzy Logic and Simple Additive Weighting (SAW) using the Rank Order Centroid (ROC) method resulted in different sub-criteria weighting scores, so it can be said that the combination of SAW- ROC provides a more accurate and more selective selection of the number of students.

**Keywords:** Fuzzy Logic, Weighting, Rank Order Centroid, Simple Additive Weight

## 1. INTRODUCTION

The whole world is currently facing the biggest school closure ever. More than 180 countries have temporarily closed schools to reduce the spread of the COVID-19 virus (Ananda et al., 2021; Asmuni, 2020; Dewi, 2020; Sari et al., 2021). The education system faces extraordinary problems as school closures have halted or significantly reduced learning, while economic downturns worldwide have also impacted parents and schools. (Adha et al., 2020; Indrawati, 2020). The number of unemployed increases as family incomes decrease and the government's tax space decreases, affecting the foreign aid budget (Indayani & Hartono, 2020; Jalil et al., 2020). This problem is simultaneously observed all over the world. Seeing the increase in cases from the beginning of their emergence, which began to spread in Indonesia, the Indonesian government then made several policies to control and break the chain of the spread of Covid-19.

During the Covid-19 pandemic, several efforts that the government has made about learning activities during the Covid-19 pandemic are aimed at making the learning process run smoothly so that learning success is achieved. One of the things that can be used as a reference to see the success of the learning process is student learning outcomes (Saputra et al., 2018; Syachtiyani & Trisnawati, 2021). Learning outcomes result from the interaction process, learning process, and learning evaluation carried out by teachers and students through learning activities (Nurrita, 2018). The learning outcomes obtained by students will indicate the success or failure of the learning activities that have been carried out (Ana, 2019). In addition to paying attention to learning outcomes, teachers must also pay attention to student learning satisfaction in the online learning process. This is because learning satisfaction is an emotional state that shows a pleasant and unpleasant impression of the various activities. The measure of learning satisfaction can be seen from the increase or development of differences in performance from time to time (Putra, 2019). Several factors influence student learning satisfaction, such as teacher attendance, teacher expertise, and learning quality (Nuramalina et al., 2019).

It's just that the reality shows that not all teachers understand and know the learning outcomes and learning satisfaction possessed by students during the online learning process (Nurrohim, 2020). Teachers tend to focus more on meeting learning objectives without paying attention to student satisfaction (Nilayani, 2020). So that many students are lazy to study and impact decreasing learning outcomes. To overcome these problems, an effort is needed to determine student learning outcomes and satisfaction with distance learning during the Covid-19 pandemic. One of the efforts that can be done is to weigh the learning outcomes and student learning satisfaction.

The weighting process is generally carried out using the Simple Additive Weighting (SAW) method (Arifin et al., 2021; Wilarto & Salamah, 2020). The Simple Additive Weighting (SAW) method is one of the methods in the Decision Support System that is often used in research (Pahu, 2018; Simarmata et al., 2018). Due to its easy use or calculation. The simple algorithm can be easily implemented on various research and programming platforms (Nurrahmi & Misbahuddin, 2019). The decision results have also been able to be combined with other methods. It's just that the SAW method still has shortcomings in the weighting system of the criteria and sub-criteria. The weighting system in this method is usually taken from an expert in the field according to the research case study or based on his understanding and juxtaposed with the application of a simple Fuzzy Logic system. (Angeline & Astuti, 2018; Ghazali et al., 2022).

The results obtained in the Simple Additive Weighting (SAW) method are then compared using fuzzy logic and Rank Order Centroid (ROC). The Rank Order Centroid (ROC) method is one method that can be used in determining the weight score other than

Fuzzy Logic and AHP (Badaruddin, 2019; Mail & Utomo, 2020; Silvilestari, 2019). The entropy ROC method is quite easy to implement. ROC weighting has been widely used in various studies (Arfyanti, 2021; Mesran et al., 2019). ROC weighting is often combined with other decision support system methods to produce more accurate decision scores (Ghazali et al., 2022). By using the application of the ROC method in determining the weight score of the criteria and sub-criteria, will it affect the decision results of the SAW method? (Addenan & Susanti, 2021).

Several previous studies have shown that the application of the Simple Additive Weighting (SAW) method for the selection of the best students produces a system that can determine or select the best students with the criteria of good character, active in class, high report cards, and attendance, the weighting is done with the help of Application of Fuzzy Logic (Setiadi et al., 2018). Other studies also reveal that using a decision support system with the Simple Additive Weighting method can determine the weight score for each attribute, then proceed with a ranking process that will choose the best alternative from several alternatives (Ibrahim & Surya, 2019). Subsequent research also revealed that the determination of zakat recipients could be done by applying the SAW method with the accuracy of the test data almost reaching 90% in this research (Prayogo et al., 2018).

Based on some of the results of these studies, it can be said that the simple additive weighting (SAW) method in determining the score of sub-criteria weights uses the application of Fuzzy Logic in transforming the entity and the percentage number in changing the criteria weights. There is no determination in determining the weighting of the standards and sub-criteria in the SAW method itself. It's just that in previous studies, there were no studies that discussed weighting comparison analysis using fuzzy logic and rank order centroid (ROC) in the simple additive weighting (SAW) method. The research focused on providing accuracy in the Simple Additive Weighting method results. (SAW) in determining student learning outcomes on student learning satisfaction with distance learning during the Covid-19 pandemic, which replaces the weight score using the application of percentages on the criteria and Fuzzy Logic on the sub-criteria with the application of the Rank Order Centroid (ROC) method.

## 2. METHOD

This research is a type of applied research, where this research is directed to obtain information that can be used to solve problems. The related analysis is carried out to apply, test, and evaluate practical issues to be utilized for the benefit of humans, both individually and in groups. This applied research problem has the same score as basic research because the researcher must know about statistically processing data. This study uses the Rank Order Centroid (ROC) method in finding the weight score. The weight score is obtained from the calculation of the ROC method by calculating the weights for the criteria and weights for the sub-criteria. This score is used for the Simple Additive Weighting (SAW) method in producing a Decision Support System (DSS). The purpose of using the Rank Order Centroid method in finding the weight score is to make data accuracy in obtaining a Decision Support System (DSS) from the Simple Additive Weighting method.

The subjects involved in this study were 36 students of Vocational High School (SMK). Data collection in the study was carried out using direct observation, interviews, and questionnaires. The criteria contained in the questionnaire are factors that affect the process of student learning outcomes on learning satisfaction during the Covid-19 pandemic. The criteria used are device ownership, accessibility, ease of obtaining materials, method accuracy, monitoring ability, interactivity, and independent learning. From the seven criteria, the priority scale is determined. It is needed to determine the weight score of the two

methods being compared, namely Fuzzy Logic and Rank Order Centroid (ROC). Then the data analysis was carried out in search of the weight score on the SAW method, using two ways, namely Fuzzy Logic and ROC.

Equipment Ownership Criteria is a Top Priority which is very important. Due to all the criteria for assessing student satisfaction with learning outcomes during the Covid-19 pandemic, the most important thing is that the student must have a device. In this case, it is a smartphone. Learning will not be realized if you do not have a device. Then look for accessibility and how to access the knowledge, in this case, the network's availability. Furthermore, it can be done by the teacher to make it easier for students to get material to realize the accuracy of the method in teaching. Suppose it is appropriate in the learning method. In that case, it will indirectly increase student monitoring of the material's development, followed by interactive and independent of student learning. Before knowing the description of the proposed method, it is necessary first to describe the previous workflow. Then the flow of the initial method is changed so that a general definition of the stages of the method proposed in this study will be explained in Figure 1.
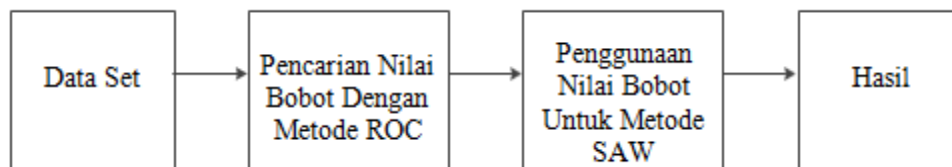


**Figure 1.** The proposed method.

## 3. RESULT AND DISCUSSION

**Result**

There are three main results obtained in this study. The first result relates to using the SAW method with fuzzy logic weighting. The search for the score of the weights on the criteria and sub-criteria is done by determining the weight scores on the criteria and sub-criteria of the SAW method with the application of the Fuzzy Logic method. The search for normalized scores on all weights is combined according to the data. Next, search for normalized scores in the SAW method to determine the max or min score according to the criteria needed. Based on the Fuzzy Logic test results, it can be explained that the search for the max score or the search for the most significant score and the min or the smallest score search depends on the criteria needed. In this case, each criterion requires a benefit so that only the max score is needed. There is no cost or min score. Furthermore, the normalization score is calculated by dividing the max score according to the SAW method formula. Because each max criterion score is 1, all score elements are separated by 1. The search for preference scores is the last part of the calculation of the SAW method. The preference calculation is the multiplication of the normalized score matrix with the weights, then the SAW preference results with the Fuzzy Logic weights.

The second result relates to using the SAW method with ROC weighting. In this method, the search for the score of the weights on the criteria and sub-criteria by determining the score of the weight on the criteria and sub-criteria of the ROC method with the application of the ROC method. The search for normalized scores on all weights is combined according to the data. Next, search for normalized scores in the SAW method to determine the max or min score according to the criteria needed. Based on the test results, it displays the weight of the sub-criteria with each criterion that has been searched for by calculating the ROC and determining the max score. Next is to find the normalization score. Furthermore,

the normalization score is calculated by dividing the max score according to the SAW method formula. Due to each criterion required max, the normalization calculation is the element score divided by the max score. Furthermore, the search for preference scores is the last part of the calculation of the SAW method. The preference calculation is the multiplication of the normalized score matrix with the weights. In this case, the weight is the score contained in the criteria. The results of the calculation of the preference for the SAW method using the weighting criteria of the ROC method.

The third result compares the results of the analysis of the two methods. The results of the SAW method with the weight of the Fuzzy Logic sub-criteria and the SAW with the weight of the ROC sub-criteria to know the changes in the results of the number of students who are considered satisfied with the learning process during the Covid-19 pandemic, as well as how far the score optimization is carried out from the combination of the two methods. The author categorizes students who are satisfied and dissatisfied with learning outcomes during the Covid-19 pandemic. For the SAW-Fuzzy Logic standard, the score is 1.50, while for the SAW-ROC standard, the score is 0.60. The results of comparing the two methods are shown in Table 1.

**Table 1.** Comparison Results of SAW-Fuzzy Logic and SAW-ROC

| SAW-Fuzzy Logic | | | SAW-ROC | | |
|---|---|---|---|---|---|
| Alternative | Score | Result | Alternative | Score | Result |
| X1 | 2.475 | satisfied | X1 | 0.722 | satisfied |
| X2 | 2.55 | satisfied | X2 | 0.761 | satisfied |
| X3 | 1.125 | not satisfied | X3 | 0.467 | not satisfied |
| X4 | 2.3 | satisfied | X4 | 0.703 | satisfied |
| X5 | 1.45 | not satisfied | X5 | 0.515 | not satisfied |
| X6 | 0.4 | not satisfied | X6 | 0.27 | not satisfied |
| X7 | 0.7 | not satisfied | X7 | 0.361 | not satisfied |
| X8 | 2.05 | satisfied | X8 | 0.625 | satisfied |
| X9 | 2.65 | satisfied | X9 | 0.808 | satisfied |
| X10 | 2.65 | satisfied | X10 | 0.808 | satisfied |
| X11 | 1.15 | not satisfied | X11 | 0.487 | not satisfied |
| X12 | 1.15 | not satisfied | X12 | 0.487 | not satisfied |
| X13 | 1.15 | not satisfied | X13 | 0.487 | not satisfied |
| X14 | 1.15 | not satisfied | X14 | 0.487 | not satisfied |
| X15 | 1.15 | not satisfied | X15 | 0.487 | not satisfied |
| X16 | 1.15 | not satisfied | X16 | 0.487 | not satisfied |
| X17 | 2.45 | satisfied | X17 | 0.708 | satisfied |
| X18 | 2.45 | satisfied | X18 | 0.708 | satisfied |
| X19 | 2.45 | satisfied | X19 | 0.708 | satisfied |
| X20 | 2.45 | satisfied | X20 | 0.708 | satisfied |
| X21 | 2.25 | satisfied | X21 | 0.694 | satisfied |
| X22 | 2.25 | satisfied | X22 | 0.694 | satisfied |
| X23 | 2.475 | satisfied | X23 | 0.757 | satisfied |
| X24 | 2.475 | satisfied | X24 | 0.757 | satisfied |
| X25 | 2.675 | satisfied | X25 | 0.771 | satisfied |
| X26 | 2.675 | satisfied | X26 | 0.771 | satisfied |
| X27 | 2.7 | satisfied | X27 | 0.791 | satisfied |
| X28 | 2.75 | satisfied | X28 | 0.823 | satisfied |
| X29 | 2.675 | satisfied | X29 | 0.771 | satisfied |
| X30 | 2.675 | satisfied | X30 | 0.771 | satisfied |

| | SAW-Fuzzy Logic | | | SAW-ROC | |
|---|---|---|---|---|---|
| Alternative | **Score** | **Result** | **Alternative** | **Score** | **Result** |
| X31 | 2.675 | satisfied | X31 | 0.771 | satisfied |
| X32 | 2.675 | satisfied | X32 | 0.771 | satisfied |
| X33 | 1.75 | satisfied | X33 | 0.595 | not satisfied |
| X34 | 1.75 | satisfied | X34 | 0.595 | not satisfied |
| X35 | 1.75 | satisfied | X35 | 0.595 | not satisfied |
| X36 | 2.05 | satisfied | X36 | 0.715 | satisfied |

From table 1, it can be seen that there is a big difference between SAW-Fuzzy Logic and SAW-ROC on the number of students who are satisfied with the learning process during the Covid-19 pandemic. From the SAW-Fuzzy Logic method, 26 alternatives are satisfied, while the SAW-ROC has 23 satisfied ones. There were sorting three alternatives to the SAW method. It is due to the improvement of the weight score carried out by the ROC method for assigning weighting criteria to the SAW method to produce accuracy or be more selective in determining the decision. Between the SAW-Fuzzy Logic method and the SAW-ROC method, there is a change in the preference score in each alternative. Changes in preference scores as in Table 2

**Table 2.** Changes in preference scores of SAW-Fuzzy Logic and SAW-ROC

| Alternative | SAW-*Fuzzy* | SAW-ROC |
|---|---|---|
| X1 | 2.475 | 0.722 |
| X2 | 2.55 | 0.761 |
| X3 | 1.125 | 0.467 |
| X4 | 2.3 | 0.703 |
| X5 | 1.45 | 0.515 |
| X6 | 0.4 | 0.27 |
| X7 | 0.7 | 0.361 |
| X8 | 2.05 | 0.625 |
| X9 | 2.65 | 0.808 |
| X10 | 2.65 | 0.808 |
| X11 | 1.15 | 0.487 |
| X12 | 1.15 | 0.487 |
| X13 | 1.15 | 0.487 |
| X14 | 1.15 | 0.487 |
| X15 | 1.15 | 0.487 |
| X16 | 1.15 | 0.487 |
| X17 | 2.45 | 0.708 |
| X18 | 2.45 | 0.708 |
| X19 | 2.45 | 0.708 |
| X20 | 2.45 | 0.708 |
| X21 | 2.25 | 0.694 |
| X22 | 2.25 | 0.694 |
| X23 | 2.475 | 0.757 |
| X24 | 2.475 | 0.757 |
| X25 | 2.675 | 0.771 |
| X26 | 2.675 | 0.771 |
| X27 | 2.7 | 0.791 |
| X28 | 2.75 | 0.823 |

| Alternative | SAW-*Fuzzy* | SAW-ROC |
|:---:|:---:|:---:|
| X29 | 2.675 | 0.771 |
| X30 | 2.675 | 0.771 |
| X31 | 2.675 | 0.771 |
| X32 | 2.675 | 0.771 |
| X33 | 1.75 | 0.595 |
| X34 | 1.75 | 0.595 |
| X35 | 1.75 | 0.595 |
| X36 | 2.05 | 0.715 |
| Total | 73.3 | 23.436 |

Based on table 2, it can be seen that the optimization of the preference score reached 31.973%. Optimization is obtained from the total preference of the SAW-ROC method of 23,436 divided by the total preference of the SAW-Fuzzy Logic method 73.3 then in the percentage to get the optimization achievement. The SAW-ROC method reduces the saw method's score to optimize the score and be accurate and more selective in making decisions.

**Discussion**

The big difference between SAW-Fuzzy Logic and SAW-ROC is the number of students satisfied with the learning process during the Covid-19 pandemic. From the SAW-Fuzzy Logic method, 26 alternatives are satisfied, while the SAW-ROC has 23 satisfied ones. There were sorting three alternatives to the SAW method. It is due to the improvement of the weight score carried out by the ROC method for assigning weighting criteria to the SAW method to produce accuracy or be more selective in determining the decision. The results obtained are the number of students who are stated to be satisfied with distance learning as many as 26 students for the weighting of the Fuzzy Logic method and 23 students for the weighting of the ROC method. Then there is 31.37% of the optimization score calculated by the ROC method on Fuzzy Logic because when using the weight score in Fuzzy Logic, the decision score is more than 1.00 the number is high.

Using the SAW method, a Decision Support System has been successfully built to produce recommendations for selected majors for students. The more data samples used, the higher the level of validity of the resulting calculation. Giving each criterion's conversion scale and preference weight affects the assessment and calculation results of SAW (Hadikristanto et al., 2021; Novianti & Yanto, 2019). The rating normalization process in the simple additive weighting algorithm compares scores within the same criteria or between criteria because the given score is converted into a relative score to the maximum score of each criterion (Hutagaol et al., 2021; Wahyuda et al., 2018). The ranking process or final results determine students in the learning process during the Covid-19 pandemic from other scores (Witasari & Jumaryadi, 2020). The application that has been built has been able to produce majors based on the criteria and weights that have been inputted into the system in a relatively short time so that it will greatly help speed up the determination of the learning outcome process during the Covid-19 pandemic, which was previously done with a manual process. (Putri, 2018).

A Decision Support System in student assessments will assist management in making decisions because it is felt that it can increase the effectiveness and efficiency of the learning outcomes process during the Covid-19 pandemic (Sahadi et al., 2020; Zaki et al., 2018). The model used to make a decision is Fuzzy Multi-Attribute Decision Making because this model chooses the best alternative from several alternatives and uses more than one criterion (Haswan & Nopriandi, 2021; Susmanto et al., 2018). With the Decision Support System more efficient in calculating the processing time for learning outcomes during the Covid-19

pandemic than the manual system, this is evidenced by the comparison between manual and computerization. (Ahmad & Kurniawan, 2020; Rifniansah, 2018).

The results obtained in this study are in line with the results of previous studies, which also revealed that the application of the Simple Additive Weighting (SAW) Method for the Selection of the Best Students resulted in a system that could determine or select the best students with criteria of good character, active in class, high grades of report cards. And attendance, the weighting is done with the help of the application of Fuzzy Logic (Setiadi et al., 2018). Other studies also reveal that using a decision support system with the Simple Additive Weighting method can determine the weight score for each attribute, then proceed with a ranking process that will choose the best alternative from several alternatives (Ibrahim & Surya, 2019). Subsequent research also revealed that the determination of zakat recipients could be done by applying the SAW method with the accuracy of the test data almost reaching 90% in this research (Prayogo et al., 2018). So it can be said that the simple additive weighting (SAW) method in determining the score of the sub-criteria weights uses the application of Fuzzy Logic in transforming the entity and the percentage number in changing the criteria weights.

## 4. CONCLUSION

Based on the research done, it can be concluded that the analysis of the search for weight scores using the Simple Additive Weighting method using Fuzzy Logic and Simple Additive Weighting using the Rank Order Centroid method produces different results sub-criteria weighting scores. Other weight scores result in different students' satisfaction with the learning process during the Covid-19 pandemic. The combination of SAW-ROC provides a more accurate and more selective selection of students. Giving a weighted score to the criteria for the Simple Additive Weighting Fuzzy Logic method has a score greater than 1, which is not found in any research where the calculation results have more than 1. This method also causes a significant decision score that does not provide optimal results.

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