
Performance Comparison of the Combination of Smarter-Fuzzy and Smarter-Fuzzy-Topsis Methods on the accuracy of the PPA Scholarship Acceptance Decision Support System

I Komang Tri Edi Wardana^{1)*}, I Made Gede Sunarya²⁾, I Gede Aris Gunadi³⁾

^{1,2,3)} Computer Science Department, Graduate Program, Ganesha University of Education, Indonesia

^{1)*} im.comink@gmail.com, ²⁾ sunarya@undiksha.ac.id, ³⁾ igedearisgunadi@undiksha.ac.id

ABSTRACT

The PPA Scholarship is a scholarship intended for students who excel, are active in campus activities, and are economically disadvantaged in accordance with predetermined conditions. Currently, in calculations often takes a long time, causing delays from the predetermined schedule and less accurate results. Based on this, it is necessary to develop a Decision Support System that can provide recommendations for prospective PPA scholarship recipients. There are 6 criteria being used, including: GPA, semester, credits, charter/certificate, assignment letter, and parent's income. In this study, comparing the performance of the combination of the Smarter-Fuzzy and Smarter-Fuzzy-Topsis methods through testing using the confusion matrix method. Smarter method is used to be able to give weighting criteria with ROC technique. The Fuzzy method is used to convert the criteria values for each alternative from 0 to 1. The Topsis method is used to rank. The ranking results of the combination Smarter-Fuzzy method show an accuracy rate of 86.6%, and the combination of the Smarter-Fuzzy-Topsis method of 75.5%.

Keywords: PPA, Smarter, Fuzzy, Topsis

INTRODUCTION

STAHN Mpu Kuturan Singaraja has the task of organizing academic, vocational and/or professional education programs, research, and community service (Regulation of the Minister of Religion of the Republic of Indonesia Number 15 of 2016) Mpu Kuturan Singaraja State Hindu Religious College has 4 Departments with 10 Study Programs, including Dharma Duta Department, Dharma Acarya Department, Dharma Sastra Department, and Brahma Widya Department. From 2016 to 2020 the acceptance of new students at STAHN Mpu Kuturan Singaraja has always increased. This shows that the public's interest in STAHN Mpu Kuturan Singaraja is increasing.

In order to ease the burden on the community, the Directorate General of Hindu Community Guidance starting in 2014 organized the PPA (Increased Academic Achievement) and BBM (Poor Scholarship Assistance) Programs, namely tuition assistance for students who are not financially able and have good academic ability. PPA scholarships are for students who excel, are active in campus activities, and are economically disadvantaged in accordance with predetermined conditions.

Previous research related to this thesis includes: research conducted by Nisa et al, 2018 entitled Employee Promotion Decision Support System. In its implementation, it obtained an accuracy of 80%. Research conducted by Firgiawan et al, 2020 entitled A Comparative Study using SAW, TOPSIS, SAW-AHP, and TOPSIS-AHP for Tuition Fee (UKT) where this research aims to compare the 4 DSS methods used in the decision-making process obtained results the experiment with the highest accuracy obtained by TOPSIS-AHP was 80%, then followed by the TOPSIS method 78%, SAW -AHP 74% and SAW 76%, so TOPSIS-AHP is the best method used in determining SPP.

* Corresponding author



At present the mechanism carried out by the Academic and Student Affairs Subdivision of the General Administration, Academic and Finance Section of STAHN Mpu Kuturan Singaraja is still using the conventional method, which in calculations often takes a long-time causing delay from the predetermined schedule. According to the Head of the Academic and Student Affairs Subdivision, the General Administration, Academic and Finance Section of STAHN Mpu Kuturan Singaraja explained that until now there has been no clear weighting and computer system to assist in recommending PPA scholarship recipients so that the results of student selection are less accurate. Judging from the experience data in 2019 there were 335 students with a quota of 130 people and in 2020 there were 441 applicants for the PPA scholarship with a quota given of 200 people. Looking at these data records, it shows that every year the applicants for PPA scholarships are increasing, so that competition from students is getting higher and causing credits. According to Hilyah Magdalena [2012], with the number of participants who have registered, the number of indicators, and the many criteria, the assessment process will be more effective and efficient if a decision support system (DSS) is applied which can help speed up the decision-making process. SPK is a system that can provide solving capabilities for semi-structured problems. Broadly speaking, decision making can be classified into 2 models, namely Multi Attribute Decision Making and Multi Objective Decision Making. The methods used in MADM such as SAW, TOPSIS, AHP.

The Simple Multi Attribute Rating Technique Exploiting Ranks (SMARTER) method is a change from the previous Simple Multi Attribute Rating Technique (SMART) method where this technique is based on the theory that each alternative of the many criteria has a value and a number of criteria have weights that draw the interests that will be compared to other criteria. SMARTER is a flexible decision-making method because of its simplicity in responding to the needs of decision makers and the analysis involved is transparent so that this method provides a high understanding of the problem and can be accepted by decision makers. The SMARTER method uses a weighting distance from 0 to 1. Rank Order Centroid is a weighting method used in the SMARTER method. ROC is used in calculating the weighting on the basis of the level of importance of each. Meanwhile, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is a decision-making method for solving problems in multi-criteria decision-making. TOPSIS has an easy-to-understand concept, with good computational time. The SAW method is used because it is able to provide fast and accurate rankings.

Based on these problems, it is necessary to make a Performance Comparison of the SMARTER-FUZZY and SMARTER-FUZZY-TOPSIS methods on decision support systems that can ease the work of the Academic Sub-Division in terms of determining student recipients of the PPA scholarship based on predetermined criteria.

LITERATURE REVIEW

Research in 2017 entitled Application of a Decision Support System for Giving Discounts to Resellers Using the Simple Multi-Attribute Rating Technique Exploiting Ranks (SMARTER) Method. The research aims to increase sales of a product and provide appreciation/awards to resellers. The criteria used are the number of purchases, purchase intensity, reseller quality, and method of delivery. The research obtained an accuracy of 80%. Research in 2018 with the title Support System for Employee Promotion Promotion. The purpose of this study was to determine the combination of the two methods, SMARTER and TOPSIS, so that they can be used in providing recommendations to leaders, where the accuracy obtained is 80%. Research in 2020 with the title Combination of the SMART Method and TOPSIS in providing recommendations for areas for developing palm oil mills. The SMART method as the first step is to find the weight on each attribute and then proceed with the TOPSIS method as the selection of the best alternative. The results obtained in the combination of the two methods got the best preference value of 0.905 and the lowest 0.128. Research in 2020 entitled SMART and TOPSIS Method For Determining the Priority of Screen Printing. This study uses the SMART method for weighting criteria and the TOPSIS method for product selection. The results of the research are priority websites for screen printing production with the best final score of 0.62 and the worst final score of 0.35 with an accuracy level between manual and system calculations reaching 100%.

* Corresponding author



Decision Support System

Decision Support System is a computerized system that is intended to provide recommendations to decision makers in utilizing certain data and models to solve various semi-structured and unstructured problems. The concept of a Decision Support System (DSS) or Decision Support System (DSS) was first published in the early 1970s by Michael S. Scott Morton the term used is Management Decision Systems.

Smarter Method

The SMARTER (Simple Multi Attribute Rating Technique Exploiting Ranks) method is an improvement from the SMART (Simple Multi Attribute Rating Technique) method described by Edwards and Baron (1994), namely these two methods are used to determine the weight of each criterion in a decision making. The weight of each criterion that is owned determines the level of importance of the criterion. This technique is based on the theory that each alternative of the many criteria has a value and a number of criteria have weights that draw the interests that will be compared with other criteria. The SMARTER method uses a weighting distance from 0 to 1. Rank Order Centroid is a weighting method used in the SMARTER method. This ROC is based on the level of importance or priority of the criteria.

ROC Weighting Technique

The ROC weighting technique is focused on the level of importance or priority of each criterion. According to Jeffreys and Cockfield (2008), the weight given to the ROC method is based on the level of importance or priority of each criterion. What is usually done is to make the statement "The 1st criterion is more important than the 2nd criterion, which is more important than the 3rd criterion" and so on until the nth criterion or the last criterion, written CR1 CR2 CR3 up to CRn. To determine the weight, the same rules are used, namely W1 W2 W3 up to Wn where W1 is the weight for criterion C1.

If, $CR_1 \geq CR_2 \geq CR_3 \geq \dots CR_n \dots \dots \dots$ (1)

Then, $W_1 \geq W_2 \geq W_3 \geq \dots W_n \dots \dots \dots$ (2)

And then, if k is the number of criteria, then:

$$W_1 = \frac{(1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{k})}{k} \dots \dots \dots (3)$$

$$W_2 = \frac{(0 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{k})}{k} \dots \dots \dots (4)$$

$$W_3 = \frac{(0 + 0 + \frac{1}{3} + \dots + \frac{1}{k})}{k} \dots \dots \dots (5)$$

$$W_4 = \frac{(0 + \dots + 0 + \frac{1}{k})}{k} \dots \dots \dots (6)$$

In general, if k is the number of criteria, then the weight of the k criteria:

$$W_k = \frac{1}{k} \sum_{i=k}^k \frac{1}{i} \dots \dots \dots (7)$$

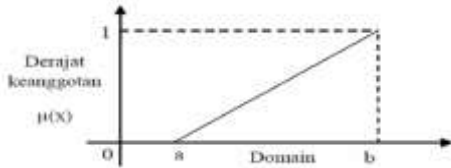
Fuzzy Method

Fuzzy is a computer-based system and control-based data acquisition for problem solving. The Fuzzy method has a possible membership value between 0 and 1. Even though the membership values are similar, the Fuzzy method can distinguish the value of the membership from the weight it has. The Fuzzy method can provide modeling of non-linear functions that are very complete and have tolerance for imprecise data using natural language so that it is easy to understand.

* Corresponding author



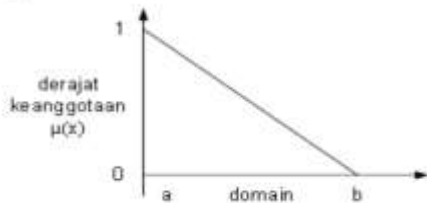
1) Linear Membership Function Ascending



Picture 1. Linear Membership Function Ascending

$$\mu(x) = \begin{cases} 0; & x \leq a; \\ \frac{x-a}{b-a}; & a \leq x \leq b; \\ 1; & x \geq b; \end{cases}$$

2) Downward Linear Membership Function



Picture 2. Downward Linear Membership Function

$$\mu(x) = \begin{cases} 0; & x \geq b \\ \frac{b-x}{b-a}; & a \leq x \leq b; \\ 1; & x \leq a \end{cases}$$

TOPSIS

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is one of the decision-making methods developed in 1981 by Yonn and Hwang. The TOPSIS method is widely used to solve practical decision-making problems to solve multi-criteria decision-making problems. The advantages of the TOPSIS method are:

- 1) Has a simple and easy-to-understand concept
- 2) Efficient computing time

TOPSIS steps as follows.

- 1) Analyze problem solving to determine problem solving criteria.
- 2) Describes n alternatives and m criteria into a matrix, where x_{ij} is the data value obtained from the results of data processing or obtained from the measurement decision-making assessment for alternative i to criterion j.
- 3) Form a normalized decision matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_i^n (x_{ij})^2}};$$

- 4) Calculates a weighted decision matrix
 $v_{ij}(x) = w_j r_{ij}(x);$

- 5) Determine positive and negative ideal values

- 6) Calculate the distance between alternatives
Distance between alternative A_i and positive ideal solution:

* Corresponding author



$$D_i^+ = \sqrt{\sum_{j=1}^m [v_{ij}(x) - v_j^+(x)]^2}; \dots\dots\dots (8)$$

Distance between alternative Ai and negative ideal solution :

$$D_i^- = \sqrt{\sum_{j=1}^m [v_{ij}(x) - v_j^-(x)]^2}; \dots\dots\dots (9)$$

where:

D_i^- = alternative distance Ai with the negative ideal solution

$v_j^+(x)$ = positive ideal solution [i],

$v_j^-(x)$ = negative ideal solution [i]

$v_{ij}(x)$ = weighted normalized matrix [i][j]

7) Specifies the preference value

$$C_i = \frac{D_i^-}{(D_i^+ + D_i^-)}; \dots\dots\dots (10)$$

where:

C_i = closeness of each alternative to the ideal solution

D_i^+ = alternative distance Ai with positive ideal solution

D_i^- = alternative distance Ai with negative ideal solution

A larger C_i value indicates that the alternative Ai is preferred

METHOD

According to Sugiyono the research method is basically a scientific way to obtain data with specific purposes and uses. This research began by observing the process of awarding the PPA scholarship at STAHN Mpu Kuturan Singaraja. In awarding PPA scholarships that have been going on so far, they are still not on target due to various factors that can cause this to happen, namely:

- 1) there is no clear weighting
- 2) still using the manual method in determining students who are entitled to receive scholarships, so data processing is less effective and requires a relatively long time
- 3) the number of participants who have registered and the criteria for evaluation are many, so there is often subjectivity among decision makers.

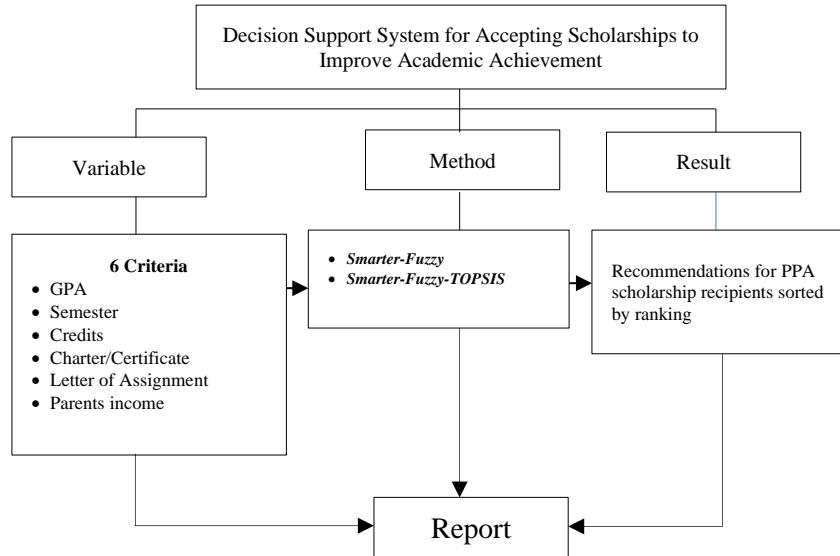
Seeing this, it is necessary to have a system that can help provide recommendations for assessment and ranking of prospective PPA scholarship recipients.

Research Concept Framework

In this study there are 6 criteria used in making decisions which will be given their respective weights using the Smarter method based on the priority of these criteria. After the weights are determined by the Smarter method, the Fuzzy method calculates the weights of the sub-criteria by differentiating "benefit" criteria using an ascending linear curve and "cost" criteria using a descending linear curve. Furthermore, the Smarter and Topsis methods carry out rankings so that they get recommendations for PPA scholarship recipients. The research concept framework can be seen in Figure 3.

* Corresponding author





Picture 3. Research Concept Framework

The criteria used for making decisions on granting PPA scholarships at STAHN Mpu Kuturan Singaraja are Grade Point Average (GPA), Semester, SKS, Charter / Certificate, Letter of Assignment / SK, and Parents' Income. The priority of each criterion is as follows.

Table 1. Priority Criteria

Criteria	Priority
GPA (C1)	1
Semester (C2)	2
Credits (C3)	3
Charter/Certificate (C4)	4
Letter of Assignment (C5)	5
Parents Income (C6)	6

From the priority shown in Table. 1 can be determined the weight on each criterion using the ROC method with the following equation.

$$GPA = \frac{1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6}}{6} = 0,408;$$

$$Semester = \frac{0 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6}}{6} = 0,242;$$

$$Credits = \frac{0 + 0 + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6}}{6} = 0,158;$$

$$Charter/Certificate = \frac{0 + 0 + 0 + \frac{1}{4} + \frac{1}{5} + \frac{1}{6}}{6} = 0,102;$$

$$Letter Of Assignment = \frac{0 + 0 + 0 + 0 + \frac{1}{5} + \frac{1}{6}}{6} = 0,061;$$

$$Parents Income = \frac{0 + 0 + 0 + 0 + 0 + \frac{1}{6}}{6} = 0,028;$$

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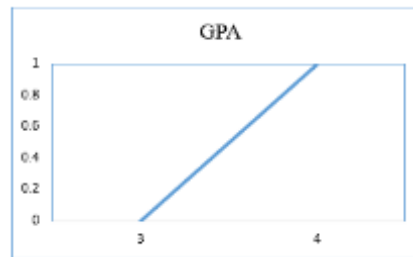
Table 2. Criteria Weight

Kriteria	Bobot
GPA (C1)	0,408
Semester (C2)	0,242
Credits (C3)	0,158
Charter/Certificate (C4)	0,102
Letter of Assignment (C5)	0,061
Parents Income (C6)	0,028

After obtaining the weight of the criteria, then calculate the weight of the sub-criteria using the Fuzzy method. Linear graphs increase for criteria that are benefit and linear graphs that decrease for criteria that are cost.

1) GPA

The Grade Point Average (GPA) is the value of student academic achievement while attending lectures that have

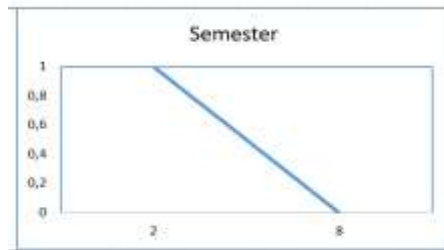


Picture 4. Linear Graph Going Up GPA

$$\mu_{C1}[x] = \begin{cases} 0; & x \leq 3; \\ \frac{x-3}{4-3}, & 3 < x < 4; \\ 1; & x \geq 4; \end{cases}$$

2) Semester

Semester is the smallest unit of time used to express the length of the process of teaching and learning activities.



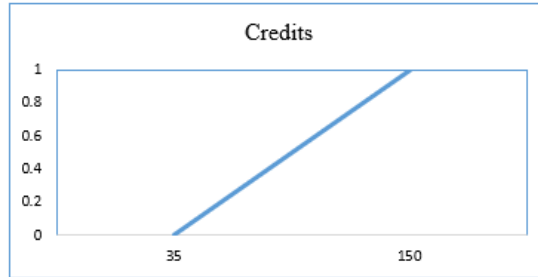
Picture 5. Linear Graph Going Down Semester

$$\mu_{C2}[x] = \begin{cases} 1; & x \leq 2; \\ \frac{8-x}{8-2}, & 2 < x < 8; \\ 0; & x \geq 8 \end{cases}$$

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3) Credits

Credits or semester credit unit is the study load in each course.

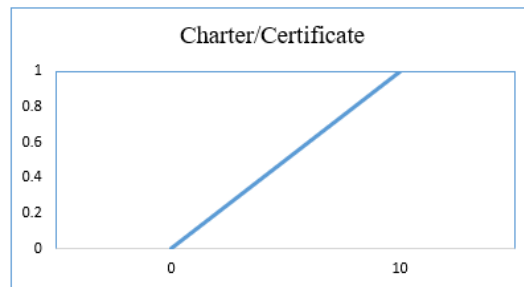


Picture 6. Linear Graph Going Up Credits

$$\mu_{C3}[x] = \begin{cases} 0; & x \leq 35; \\ \frac{x-35}{150-35}, & 35 < x < 150; \\ 1; & x \geq 150; \end{cases}$$

4) Charter/Certificate

Charter/Certificate is an official letter containing a statement of rights or so on.

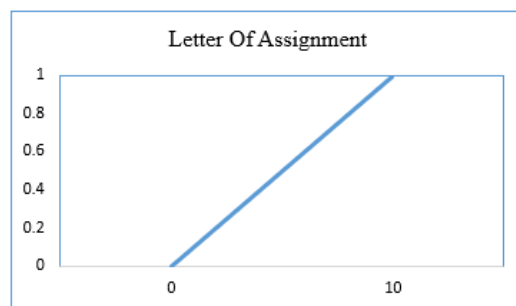


Picture 7. Linear Graph Going Up Charter/Certificate

$$\mu_{C4}[x] = \begin{cases} 0; & x \leq 0; \\ \frac{x-0}{10-0}, & 0 < x < 10; \\ 1; & x \geq 10 \end{cases}$$

5) Letter of Assignment

Letter of Assignment is an official letter issued by the institution to the person concerned to carry out certain tasks.



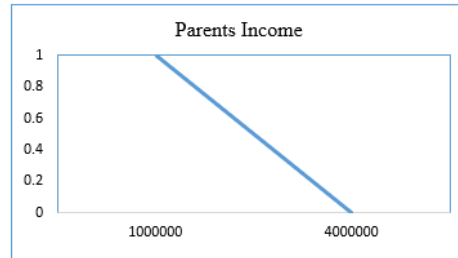
Picture 8. Linear Graph Going Up Letter of Assignment

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$$\mu_{C5}[x] = \begin{cases} 0; & x \leq 0; \\ \frac{x-0}{10-0}, & 0 < x < 10; \\ 1; & x \geq 10 \end{cases}$$

- 6) Parents Income
Parents' income is the combined income of both parents.



Picture 9. Linear Graph Going Down Parents Income

$$\mu_{C6}[x] = \begin{cases} 1; & x \leq 1000000; \\ \frac{4000000-x}{4000000-1000000}, & 1000000 < x < 4000000; \\ 0; & x \geq 4000000; \end{cases}$$

RESULT AND DISCUSSION

The amount of data used is 441 PPA STAHN Mpu Kuturan Singaraja scholarship sample data with the assumption of an acceptance quota of 200. The data will be processed for calculations with a decision support system using a combination of Smarter, Fuzzy and Topsis methods, then a comparison of test methods will be carried out using the Confusion Matrix.

Table 3. Sample data of prospective PPA scholarship recipients

NO	ALTERNATIF	C1	C2	C3	C4	C5	C6
1	A1	3,34	6	124	8	5	1000000
2	A2	3,24	6	124	2	4	1555000
3	A3	3,25	6	124	0	4	1250000
4	A4	3,43	6	124	0	0	1000000
5	A5	3	2	38	5	5	2500000
...
439	A439	3,33	2	42	8	6	1350500
440	A440	3,3	6	124	7	6	1300000
441	A441	3,3	2	42	0	2	2500000

* Corresponding author



Table 4. Weighing the value of each alternative with Fuzzy

NO	ALTERNATIF	C1	C2	C3	C4	C5	C6
1	A1	0,113	0,333	0,774	0,8	0,5	1
2	A2	0,08	0,333	0,774	0,2	0,4	0,815
3	A3	0,083	0,333	0,774	0	0,4	0,917
4	A4	0,143	0,333	0,774	0	0	1
5	A5	0	1	0,026	0,5	0,5	0,5
...
439	A439	0,11	1	0,061	0,8	0,6	0,883
440	A440	0,1	0,333	0,774	0,7	0,6	0,9
441	A441	0,1	1	0,061	0	0,2	0,5
	Min	0	0	0,026	0	0	0
	Max	0,313	1	1	0,9	0,8	1

Refer to Table. 4, namely weighting each alternative, then ranking with the Smarter and Topsis methods. In the Smarter method, the next step is to calculate the utility value with the following equation.

$$u_i(a_i) = \frac{c_{out} - c_{min}}{c_{max} - c_{min}}$$

$$u_1(a_1) = \frac{0,113 - 0}{0,313 - 0} = 0,361;$$

$$u_2(a_1) = \frac{0,333 - 0}{0,333 - 0} = 0,333;$$

$$u_3(a_1) = \frac{1 - 0}{0,774 - 0,026} = 0,768;$$

$$u_4(a_1) = \frac{0,8 - 0}{0,9 - 0} = 0,889;$$

$$u_5(a_1) = \frac{0,5 - 0}{0,8 - 0} = 0,625;$$

$$u_6(a_1) = \frac{1 - 0}{1 - 0} = 1;$$

The next step is to multiply the utility value by the weight of each criterion.

Table 5. Utility value with the Smarter method

NO	ALTERNATIF	C1	C2	C3	C4	C5	C6	Total
1	A1	0,361* 0,408	0,333* 0,242	0,768* 0,158	0,889* 0,102	0,625* 0,061	1* 0,028	0,507
2	A2	0,256* 0,408	0,333* 0,242	0,768* 0,158	0,222* 0,102	0,5* 0,061	0,815* 0,028	0,383
3	A3	0,265* 0,408	0,333* 0,242	0,768* 0,158	0* 0,102	0,5* 0,061	0,917* 0,028	0,366
4	A4	0,457* 0,408	0,333* 0,242	0,768* 0,158	0* 0,102	0* 0,061	1* 0,028	0,416
5	A5	0* 0,408	1* 0,242	0* 0,158	0,556* 0,102	0,625* 0,061	0,5* 0,028	0,351
...
439	A439	0,351* 0,408	1* 0,242	0,036* 0,158	0,889* 0,102	0,75* 0,061	0,883* 0,028	0,553
440	A440	0,319* 0,408	0,333* 0,242	0,768* 0,158	0,778* 0,102	0,75* 0,061	0,9* 0,028	0,483
441	A441	0,319* 0,408	1* 0,242	0,036* 0,158	0* 0,102	0,25* 0,061	0,5* 0,028	0,407

After ranking with a combination of the Smarter Fuzzy method, then do the ranking with a combination of the Smarter-Fuzzy-Topsis method with the following steps.

- 1) Form a normalized matrix referring to the table. 4 can be shown in Table. 6.
- 2) Calculating the weighted normalized matrix with the equation that multiplies the table normalized matrix. 6 with the weight of each criterion in Table. 2.

* Corresponding author



Table 6. Topsis normalized matrix

NO	ALTERNATIF	C1	C2	C3	C4	C5	C6
1	A1	0.032608	0.021879	0.062692	0.07247	0.04768	0.067979
2	A2	0.023017	0.021879	0.062692	0.018118	0.038144	0.055403
3	A3	0.023976	0.021879	0.062692	0	0.038144	0.062314
4	A4	0.041239	0.021879	0.062692	0	0	0.067979
5	A5	0	0.065637	0.002113	0.045294	0.04768	0.03399
...
439	A439	0.031649	0.065637	0.004931	0.07247	0.057216	0.060037
440	A440	0.028772	0.021879	0.062692	0.063411	0.057216	0.061181
441	A441	0.011739	0.015884	0.000779	0	0.001163	0.000952

Table 7. Weighted normalized matrix

NO	ALTERNATIF	C1	C2	C3	C4	C5	C6
1	A1	0.013304	0.005295	0.009905	0.007464	0.002908	0.001903
2	A2	0.009391	0.005295	0.009905	0.001866	0.002327	0.001551
3	A3	0.009782	0.005295	0.009905	0	0.002327	0.001745
4	A4	0.016826	0.005295	0.009905	0	0	0.001903
5	A5	0	0.015884	0.000334	0.004665	0.002908	0.000952
...
439	A439	0.012913	0.015884	0.000779	0.007464	0.00349	0.001681
440	A440	0.011739	0.005295	0.009905	0.006531	0.00349	0.001713
441	A441	0.011739	0.015884	0.000779	0	0.001163	0.000952
	Min	0	0	0,026	0	0	0
	Max	0,313	1	1	0,9	0,8	1

1) Calculate the distance between positive ideal (A⁺) and negative ideal (A⁻).

$$D_1^+ = \sqrt{\frac{(0.013304 - 0,313)^2 + (0.005295 - 1)^2 + (0.009905 - 1)^2 + (0.007464 - 0,9)^2 + (0.002908 - 0,8)^2 + (0.001903 - 1)^2}{6}} = 0,025993;$$

$$D_1^- = \sqrt{\frac{(0.013304 - 0)^2 + (0.005295 - 0)^2 + (0.009905 - 0,026)^2 + (0.007464 - 0)^2 + (0.002908 - 0)^2 + (0.001903 - 0)^2}{6}} = 0,01909;$$

Table 8. The distance between ideal positive and negative ideal values

NO	ALTERNATIF	A ⁺	A ⁻
1	A1	0.025993	0.01909
2	A2	0.030314	0.014803
3	A3	0.030421	0.01496
4	A4	0.024717	0.020159
5	A5	0.039066	0.016835
...
439	A439	0.026767	0.022135
440	A440	0.027432	0.017754
441	A441	0.029244	0.019813

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2) Define preference values $C_1 = \frac{0,01909}{0,025993+0,01909} = 0,423441$;

Table 7. Preference Matrix

NO	ALTERNATIF	C
1	A1	0.423441
2	A2	0.328102
3	A3	0.329653
4	A4	0.449216
5	A5	0.301157
...	...	
439	A439	0.45264
440	A440	0.392909
441	A441	0.403877

The ranking of experts and decision support system methods are presented in Table. 10.

Table 8. Expert Ranking with SPK

Ranking	Expert	Smarter-Fuzzy	Smarter-Fuzzy-Topsis
1	A345	A345	A75
2	A106	A106	A230
3	A89	A75	A345
4	A52	A52	A362
5	A111	A111	A231
...
439	A3	A186	A409
440	A46	A329	A131
441	A380	A151	A46

After getting the ranking from the decision support system method, then do the testing by comparing the ranking results from the experts using the confusion matrix method as follows.

1) Testing the combination of the Smarter-Fuzzy method

Table 9. Testing the Smarter-Fuzzy Method

	Positive	Negative
True	171	212
False	29	29

$$Accuracy = \frac{171+212}{441} = 86,6\%;$$

$$Precision = \frac{171}{171+29} = 85,5\%;$$

$$Recall = \frac{171}{171+29} = 85,5\%;$$

* Corresponding author



2) Testing the combination of the *Smarter-Fuzzy-Topsis method*

Table 10. Testing the *Smarter-Fuzzy-Topsis method*

	Positive	Negative
True	146	187
False	54	54

$$Accuracy = \frac{146+187}{441} = 75,5\%;$$

$$Precision = \frac{146}{146+54} = 73\%;$$

$$Recall = \frac{146}{146+54} = 73\%;$$

CONCLUSION

Based on testing of the combination of the Smarter-Fuzzy and Smarter-Fuzzy-Topsis methods by utilizing the confusion matrix, an accuracy value of 86.6% was obtained for the combination of the Smarter-Fuzzy method and 75.5% for the combination of the Smarter-Fuzzy-Topsis method.

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* Corresponding author

