

## **Selection of Promotional Media With The Integration of AHP Fuzzy and TOPSIS (Case Study in a Study Program)**

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### **Abstract**

Private universities need new students as one of the income to be able to run their operations. For that promotion needs to be done by them. When carrying out promotional activities, it is necessary to look at the availability of the budget, so it is necessary to be selective and choose the right promotional media and according to the budget. Selection of promotional media in addition to considering buget, there are several criteria that must be considered, therefore the selection requires a multi-criteria method, one of which is TOPSIS. Initial weighting of the criteria for TOPSIS can be done with Fuzzy AHP, this method is used because it can overcome the fuzzy assesment when performing pairwise comparisons. So far, there are not many combined applications of Fuzzy AHP and TOPSIS in the selection of promotional media, so this research is expected to have a contribution to fill the gap. From the results of the study, it was found that the order of criteria that were important for the study program in the selection of promotional media were; cost, reach, audience fit and easy to apply. Meanwhile, the result of selecting the best promotional media for this study program was through social media.

**Keywords:** Fuzzy AHP; TOPSIS; Promotion Media, Multi Criteria

### **INTRODUCTION**

In a private university, students are the main source of funds for the development of a private university, as well as support for the operational financing of the university. To obtain new students, promotions are needed for universities, in addition to being increasingly known by the public and becoming an option for further studies.

Attitude Towards Advertisement is known to have an influence on one's intentions (Utomo et al., 2020). In addition, promotional strategies significantly impact buying intentions (Kaur et al., 2022). Promotions can also affect brand awareness and brand loyalty (Tufa & Workineh, 2022). Likewise, advertising can affect brand awareness, brand loyalty, and consumer buying behavior (Zhao et al., 2022)

In a selection with several criteria, it is preferable to utilize a multi-criteria technique, one of which is Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) (Hwang & Yoon, 1981). The first weight of criteria that can be obtained from the assessment process is required for TOPSIS evaluation. TOPSIS can be combined with other weighting methods, as done by Utomo in the case of supplier selection (Utomo, 2015). To circumvent this, the approach can be used with the Analytical Hierarchy Process (AHP). AHP is a method that can be useful in weighting criteria and selecting the best alternative with multi criteria (T. L. Saaty, 2004).

The Fuzzy Analytical Hierarchy Process can be utilized to overcome the indeterminate evaluation resulting from the comparison of these criteria. Therefore, a combination of TOPSIS and Fuzzy AHP will be employed in this investigation.

There were several studies related to the selection of promotional media. A study applied AHP and TOPSIS relating Promotion Media (Fadilah et al., 2019) . Amgalanbaatar and Batnasan studied the selection by applying Linear Programming and Machine Learning (Amgalanbaatar & Batnasan, 2022). While , Piya et al applied DEA and DEMATEL to Evaluation of Advertising Media Functions (Piya et al., 2022). Related to the application of the MCDM method by combining Fuzzy AHP and TOPSIS, several previous researchers have carried out different cases. Siburian et al conducted a study with Fuzzy AHP-TOPSIS for Green Management Practice (Siburian et al., 2022). In addition, there was also a study that used Fuzzy AHP and TOPSIS for the case of evaluating the performance of corporate social responsibility (Yi et al., 2022). From this background, it can be seen that research on Fuzzy AHP and TOPSIS for the

selection of promotional media is still lacking in application, this research fills the gap by using Fuzzy AHP and TOPSIS to select promotional media.

**LITERATURE REVIEW**

In promotional activities, sometimes there are several criteria used to select the media to be used. In carrying out promotions, not all organizations have large costs, so they must be in accordance with the available budget. Therefore, Cost is a criterion to be considered. There are previous studies that have used Cost in selecting web sites for online advertising (Ngai, 2003). In addition, the media used must be easy to use (Easy to apply), these criteria have also been proven in the criteria related to the selection of advertising media (Ngai, 2003). Advertisements delivered by the media are expected to be accessible to the audience according to the desired target. Therefore, the suitability of the audience when choosing advertising media needs to be considered. Several studies have used these criteria regarding the selection of advertising media (Ngai, 2003) (Sun & Chi, 2019). The use of promotional media is expected to have a broad reach in reaching potential consumers. Therefore, this criterion deserves to be considered.

AHP is a decision-making technique that uses multiple criteria and pairwise comparisons (T. L. Saaty, 2004). To overcome the assessment of pairwise comparisons that are uncertain or fuzzy, a fuzzy scale can be used. Fuzzy is a fuzzy value that is between 0 and 1 (Zadeh, 1996). Chang developed an AHP solution methodology that can use a fuzzy scale so that it becomes a fuzzy AHP (Chang, 1996). Meanwhile TOPSIS was developed by Yoon and Hwang which can solve multi-criteria decision-making problems, taking into account the distance to the ideal value (Hwang & Yoon, 1981). Some studies combined TOPSIS with other criteria-weighted methods such as with AHP (Abdulvahitoglu & Kilic, 2022)(Li et al., 2022)(Rajput et al., 2022) , and also combined TOPSIS with Fuzzy AHP (Yadav et al., 2022)(Nabizadeh et al., 2022).(Ekmekcioğlu et al., 2021)(Khodamipour et al., 2021)

**METHODS**

This study used a combination of Fuzzy AHP and TOPSIS methods. In Fuzzy AHP, the following steps are used: (Chang, 1996) :

1. Pairwise Comparison between criteria with Fuzzy Number
2. Determining the value of Fuzzy synthesis
3. Computing of the degree of fuzzy membership
4. Weight normalization

The results of the weighting of the criteria were then used as input for calculating TOPSIS. The steps for working on TOPSIS are as follows (Hwang & Yoon, 1981) :

1. Alternative assessment
2. Developing a normalized decision matrix
3. Using the weight multiplied by the value of each attribute
4. Determine the positive ideal solution matrix and the negative ideal solution matrix
5. Determine the distance between the values of each alternative and the ideal solution matrix for the positive and negative cases.
6. Determine the value of each alternative's preference

**RESULT AND DISCUSSION**

Fuzzy AHP calculations follow the steps described in the method section. The results of the pairwise comparison using the AHP scale (table 1) was a comparison between the criteria assessed by the management of the university, which in this case is the part of decision making the promotion planning in the study program.

**Table 1. Pairwise comparison of criteria with AHP scale**

	Cost (C1)	Reach (C2)	Easy (C3)	Audience (C4)
Cost (C1)	1	4	4	3
Reach (C2)		1	3	2
Easy (C3)			1	1
Audience (C4)				1

A consistency test was conducted to ensure the consistency of the pairwise comparisons. Regarding the pairwise comparability consistency test. The obtained Consistency Index (CI) equals 0.059. The Ratio Index (RI) for the matrix with n = 4 is 0.90. Consequently, the value of consistency ratio (CR) = CI/RI = 0.059/0.9, CR = 0.066. Due to the fact that the CR value found in this study is less than 0.1, the pairwise comparisons are consistent (R. W. Saaty, 1987)

The assessment was converted into a fuzzy scale, which in this case used a triangular fuzzy number, the number was divided into low (l), medium (m) and upper (u). Same as pairwise comparisons with AHP, Fuzzy AHP also performed

pairwise comparisons with values which was fuzzy. The results of the comparison of criteria with fuzzy values could be seen in table 2.

**Table 2. Pairwise comparison of criteria with Fuzzy scale**

Criteria	Cost (C1)			Reach (C2)			Easy (C3)			Audience (C4)		
	l	m	u	l	m	u	l	m	u	l	m	u
Cost (C1)	1	1	1	1.5	2	2.5	1.5	2	2.5	1	1.5	2
Reach (C2)	0.4	0.5	0.7	1	1	1	1	1.5	2	0.5	1	1.5
Easy (C3)	0.4	0.5	0.7	0.5	0.7	1	1	1	1	1	1	1
Audience (C4)	0.5	0.7	1	0.7	1	2	0.5	0.7	1	1	1	1

After getting the pairwise comparison value with fuzzy numbers, the next step was to determine the value of fuzzy synthesis. The result was value of low (l), medium (m) and upper (u), for each criterion which in this case consisted of 4 criteria. The results of the fuzzy synthesis were described in table 3 below.

**Table 3. The value of fuzzy synthesis**

Criteria	l	m	u
Cost (C1)	0.23	0.38	0.57
Reach (C2)	0.13	0.23	0.37
Easy (C3)	0.13	0.18	0.26
Audience (C4)	0.15	0.21	0.36

After obtaining the value of the fuzzy synthesis, the next step was to determine the degree of membership of the fuzzy number for each criterion. In this process the values from the previous calculations (fuzzy synthesis process) were used. The results of this process were obtained the following values:

$$\begin{aligned} \min (1.00; 1.00; 1.00) &= 1.00 \\ \min (0.49; 1.00; 1.00) &= 0.49 \\ \min (0.15; 0.73; 0.80) &= 0.15 \\ \min (0.44; 0.92; 1.00) &= 0.44 \end{aligned}$$

The process continued with the next stage, which was normalization for all existing criteria. In this process used the data that calculated in the previous process (degree of membership). The results of this process then obtained the following values:

$$\begin{aligned} W' &= (1.00; 0.49; 0.15; 0.44) \\ W &= (0.48; 0.24; 0.07; 0.21) \end{aligned}$$

In this process, the weighting of criteria using Fuzzy AHP has been completed with the obtained weights for cost of 0.48, reach of 0.24, easy of 0.07 and audience of 0.21. From these results, it could be seen that cost was the most important criterion for decision makers, followed by reach, audience and then easy. The next step was to do the TOPSIS calculation. The first step was to evaluate each alternative based on each criterion by using a scale of 1 to 5, With a value of 1 being very poor and 5 being very good. Table 4 described the results of the alternative assessments for each criterion. In this case, 3 alternative media were used that were often used for promotion, namely social media, radio and brochures. The definition of a brochure in this study is to use a physical brochure (paper) to be distributed to prospective students in schools. While radio is using radio to broadcast promotions about study programs. Meanwhile, social media is using social media as a means of promoting study programs. TOPSIS requires a weight value in the initial calculation. The weight value in table 4 was from the weight value obtained in the Fuzzy AHP calculation.

After obtaining the results of the alternative assessment for each criteria, the next step was performing a Normalized decision matrix. The results of this process could be seen in table 5.

**Table 4. Matrix of alternative rating**

Alternative	Cost (C1)	Reach (C2)	Easy (C3)	Audience (C4)
Weight	0.48	0.24	0.07	0.21
Social Media (A1)	5	5	2	5
Radio (A2)	3	3	3	2
Brochure (A3)	4	3	5	5

**Table 5. Normalized decision matrix**

Criteria	Cost (C1)	Reach (C2)	Easy (C3)	Audience (C4)
Weight	0.48	0.24	0.07	0.21
Social Media (A1)	0.71	0.76	0.32	0.68
Radio (A2)	0.42	0.46	0.49	0.27
Brochure (A3)	0.57	0.46	0.81	0.68

The results of the normalized decision matrix were then multiplied by the weight of each criterion. The weight of the criteria in this case was obtained from the calculation process using the Fuzzy AHP method. The results of the multiplication process were described in detail in table 6 below.

**Table 6. Normalized decision matrix and weight**

Criteria	Cost (C1)	Reach (C2)	Easy (C3)	Audience (C4)
Social Media (A1)	0.34	0.18	0.02	0.14
Radio (A2)	0.20	0.11	0.03	0.06
Brochure (A3)	0.27	0.11	0.06	0.14

The next step was calculating the positive ideal solution and negative ideal solution matrix. The positive ideal is the maximum value of the available alternatives for each criterion, while the negative ideal is the minimum value of the available alternatives for each criterion. The results of the positive and negative ideal solution matrix were detailed below.

$$\begin{aligned}
 &A+ \\
 &Y1 \max(0.34 \ 0.20 \ 0.27)=0.34 \\
 &Y2 \max(0.18 \ 0.11 \ 0.11)=0.18 \\
 &Y3 \max(0.02 \ 0.03 \ 0.06)=0.06 \\
 &Y4 \max(0.14 \ 0.06 \ 0.14)=0.14
 \end{aligned}$$

$$\begin{aligned}
 &A- \\
 &Y1 \min(0.34 \ 0.20 \ 0.23)=0.20 \\
 &Y2 \min(0.18 \ 0.11 \ 0.11)=0.11 \\
 &Y3 \min(0.02 \ 0.03 \ 0.06)=0.02 \\
 &Y4 \min(0.14 \ 0.06 \ 0.14)=0.06
 \end{aligned}$$

The next step was computing the distance between existing values to positive and negative ideal values. The calculation results were presented in tables 7 and 8. Then these results were used to calculate the preference value of the proximity of each alternative to the ideal solution, the results of which were described in table 9. The value is the weighted value for each alternative, the larger value is the best value. In table 9, the order of the weight values is obtained from the largest to the smallest, namely social media (0.83), brochures (0.54) and radio (0.06). This shows that in this study program the best promotional media is to use social media.

In this study, Fuzzy AHP and TOPSIS were combined, and they were able to choose the best promotional media. The same thing has been done by previous researchers, but using AHP and TOPIS for the selection of promotional media (Fadilah et al., 2019). This finding is a contribution to the science of selecting the multi-criteria method in the case of selecting promotional media.

**Table 7. Ideal positive value**

Ideal	Value
D1+	0.03
D2+	0.18
D3+	0.10

**Table 8. Ideal negative value**

Ideal	Value
D1-	0.18
D2-	0.01
D3-	0.12

**Table 9. The preference value**

Alternative	Value
Social Media (A1)	0.83
Radio (A2)	0.06
Brochure (A3)	0.54

## CONCLUSION

The conclusion of this study, Fuzzy AHP and TOPSIS are able to choose alternatives that meet the criteria for promotion of a study program at the university. The criteria used in the selection of this promotional media were cost, reach, audience suitability and ease of use. The results of weighting criteria with fuzzy AHP from the largest are cost, reach, audience, and ease of application. Meanwhile, the results of the selection of promotional media, it was found that social media is the best promotional media for decision maker (study program manager) as promotion of study programs in getting new students.

The results of this study have limitations on the number of criteria considered and further research can consider more complex criteria.

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