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Selection of promotional media on tourist boats with fuzzy AHP and fuzzy TOPSIS

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ABSTRACT

The tourism sector necessitates effective promotion to introduce tourist attractions, including tourist boats operating on the Mahakam River. Given the prevalence of the digital era, it is imperative to employ appropriate promotional channels that precisely target the intended audience. The selection of promotional media entails various criteria and alternatives, thereby making it highly suitable to employ a multi-criteria decision-making approach. Due to the inherent uncertainty in assessments, a fuzzy scale becomes indispensable. This research utilizes a combination of Fuzzy Analytic Hierarchy Process (Fuzzy AHP) and Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (Fuzzy TOPSIS) to address this issue. The findings of this study reveal that the order of importance for the criteria is as follows: Audience fit (C1), Reach (C2), Interactivity (C3), Cost (C4), Look and Feel (C5), and Frequency (C6). Regarding the selection of promotional media, social media (A1) emerges as the most effective medium when compared to web-based platforms (A2) and mobile applications (A3). The amalgamation of these two methodologies (Fuzzy AHP and Fuzzy TOPSIS) for the purpose of selecting tourism promotion media in Indonesia remains largely unexplored in prior research. Therefore, this study exhibits novelty and contributes to the existing knowledge concerning Multicriteria Decision Making and the selection of tourism promotion media in Indonesia.

1. Introduction

The Mahakam River, boasting a length of approximately 920 km (Jusmaldi et al., 2019), holds the distinction of being the longest river in the province of East Kalimantan. Its current state presents enticing opportunities for tourism, notably through the use of tourist boats. Historically, the province of East Kalimantan in Indonesia has been recognized primarily for its coal mining and oil palm plantations. However, diversification into other sectors is imperative for enhancing the regional economy, and the tourism sector stands as a viable option. Notably, the influx of tourists to a given area has been empirically linked to enhanced economic growth within that vicinity (Wu et al., 2022).

The advent of technology, particularly the internet, has greatly facilitated digital promotion through online platforms and social media. Consequently, promotional media has experienced rapid growth thanks to the pervasive influence of the internet and social media. The presence of Internet communication technology (ICT) bears the advantage of enabling interactive communication between consumers and marketers, thereby contributing to the promotion and development of tourist destinations (Ivars-Baidal et al., 2019).

Promotional activities sometimes are carried out according to the available budget (Ngai, 2003). So that the selection of the right promotional media is needed so that the budget used for promotion can be in accordance with the promotional objectives. The number of criteria in the selection of promotional media can cause confusion when making a selection, which criteria should be prioritized, and what is the best alternative based on these criteria? In order to circumvent this, the use of a multiple-criteria selection method is essential. There are several multi-criteria methods, one of which is the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) (Hwang and Yoon, 1981). The application of TOPSIS requires an initial weight for each criterion, so it can be combined with other multi-criteria methods to determine the weights for

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each criterion. The analytical hierarchy process (AHP) can overcome this, AHP is proven to be able to perform weighting for criteria (Saaty, 2004). Fuzzy AHP and Fuzzy TOPSIS have been applied in several previous studies (Baki, 2020; Nazim et al., 2022; Padma et al., 2022; Piya et al., 2022; Shukla et al., 2014; Vinh et al., 2022). The applicability of this research differs from that of the prior study. This study used the model for the selection of Indonesian tourism promotion media. This is the novelty of this research compared to previous research. The tourism sector in an area needs to be improved. Because the development of the tourism sector can increase economic growth, tourists who come to travel have the benefit of increasing the economic growth of the area (Bronzini et al., 2022; Mishra et al., 2022; Wu et al., 2022). The development of the internet and social makers also develops promotional media. In previous research, there is evidence that social media affects people's intention to visit tourist objects (Hidayat and La Are, 2018). In addition, the characteristics of social media are able to influence decisions to use social media as a means of choosing tourist visits (Pandey, 2022). Therefore, social media is used as a reference for them to do tourism. The development of social media was followed by the development of the field of online promotion. Currently, there is also promotion using influencers in tourism promotion (Caraka et al., 2022). Influencers can be partners in the marketing process of the world of tourism (Asan and Yolal, 2022) because Influencers are proven to be able to influence the decision to visit tourist attractions (Hanifah, 2019). In addition, there are technological developments that provide opportunities to promote digitally, namely through live streaming. Live streaming provides high interactivity by presenting the current situation in real-time using internet media. Meanwhile, promotions with live streaming have been shown to influence people's desire to travel (Ye et al., 2022). The development of mobile applications has another positive impact by providing advertisements as part of the mobile application (Islam et al., 2010). Meanwhile, online advertising is proven to directly affect tourist buying intentions (Khuong and Huong, 2016). Even in the COVID-19 situation in Jordan, digital marketing shows a significant influence on intentions for domestic tourism (Nofal et al., 2020).

There are several criteria used in selecting promotional media, one of which is audience fit. This criterion shows how well the media and the targeted audience are. Several previous studies used this criterion in the selection of promotional media (Calli, 2016; Ngai, 2003).

The next criterion is the reach; this criterion shows how far the promotional media can reach the targeted audience. This criterion is believed to be a criterion in the selection of promotional media (Indrayana and Utomo, 2022). The next criterion is cost. The cost factor is something that needs to be considered as a promotional media criterion, and some researchers use the cost criterion to select promotional media (Majeed and Sriram, 2019). Another criterion is Look and Feel. A previous research used this criterion as a consideration for decision making in the selection of promotional tools (Ngai, 2003). The online era makes it easier for promotional media to be more interactive (Utomo et al., 2022). Interactive criteria is one of several criteria that need to be considered in Selecting Social Network Sites for Advertisement (Calli, 2016).

Besides needing to know who your advertising media plan wants to reach, another thing to consider is setting a goal for how many times you want to reach them with your message (Katz, 2019). Therefore, the frequency of exposure to advertising needs to be considered. Previous research used the frequency criterion in selecting the best advertisement (Majeed and Sriram, 2019).

There are several methods of multi-criteria, one of the most famous is AHP. AHP is a decision-making technique that uses several criteria and pairwise comparisons (Saaty, 2004). Besides AHP, there is also the TOPSIS method. TOPSIS does not perform pairwise comparisons like AHP but does a direct assessment of each alternative on its decision criteria. TOPSIS was developed by Hwang and Yoon (1981) by looking at the ideal distance in the assessment of criteria and alternatives. In the assessment of criteria and alternatives, sometimes there are values that are uncertain, or fuzzy. Fuzzy means that there are values that are between values 0 and 1 (Zadeh et al., 1996). In order to overcome this, several researchers apply a fuzzy scale to the multi-criteria method, including Fuzzy AHP (Chang, 1996) and Fuzzy TOPSIS (Chen, 2000). Fuzzy TOPSIS itself requires an initial weight of criteria so that it is combined with Fuzzy AHP.

There are several previous studies that combined two multi-criteria methods, namely TOPSIS and AHP (Abdulvahitoglu and Kilic, 2022; Li et al., 2022; Rajput et al., 2022). In addition, there are also those that combine TOPSIS and Fuzzy AHP (Ekmekcioğlu et al., 2021; Khodamipour et al., 2022; Nabizadeh et al., 2022; Yadav et al., 2023).

In addition, there are also previous studies related to the selection of promotional media. A study conducted a selection with Linear Programming and Machine Learning (Amgalanbaatar and Batnasan, 2022). In addition, there are also Fuzzy AHP and Fuzzy TOPSIS methods for selection, in different cases, not the case for selecting promotional media (Nazim et al., 2022; Padma et al., 2022; Piya et al., 2022). And for the case of tourism, there is also the application of Fuzzy AHP and Fuzzy TOPIS in the evaluation of hotel websites (Baki, 2020).

2. Method

There are several stages in this research as follows:

- Developing criteria and alternative models: At this stage developing advertising media selection

criteria based on literature and discussions with competent parties. The results of the developed model can be seen in Fig. 1.

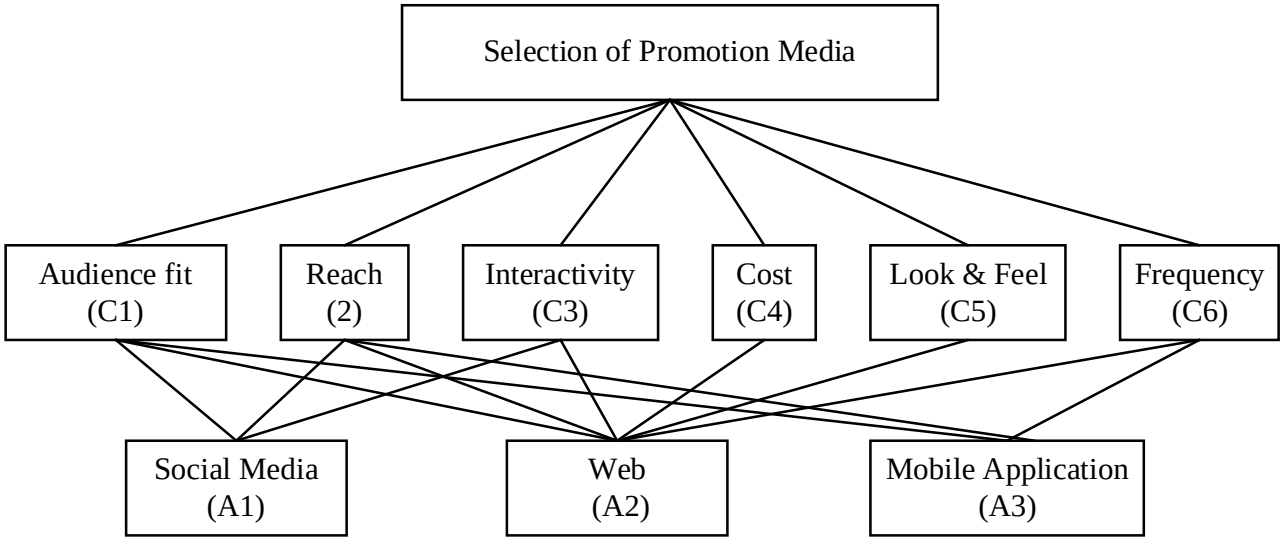

Fig.1: Model of research

- Conducting an assessment of the criteria: At this stage, pairwise comparisons are made on the criteria for selecting online promotional media for Mahakam riverboat tourism with a fuzzy scale. The scale used for comparison in this study was the fuzzy scale (Table 1). This study used a comparison of 3 expert opinions and combines these opinions with the geometric mean.
- Consistency ratio calculations: This process was carried out to ensure that pairwise comparisons on the selection criteria in this study have met the consistent requirements. Consistency ratio calculation is required to see consistency in pairwise comparisons (Saaty and Vargas, 2012). Calculating the Consistency index with the following formula:

$$CI = \frac{\lambda\, max - n}{n-1} \quad (1)$$

where, $\lambda\, max$ is the largest eigenvalue of the matrix comparison, while n is the number of rows or columns of the matrix. Then the Consistency Ratio value is obtained by the formula:

$$CR = \frac{CI}{RI} \quad (2)$$

Random Index (RI) is obtained from the Random Index table and in this study the R-value is 1.24 (n=6). The pairwise comparison is declared consistent if the RI value must be less than or equal to 0.1.

Table 1: Fuzzy AHP scale

Statement	TFN	Reciprocal TFN
Absolute (A)	(7/3, 4, 9/2)	(2/9, 1/4, 2/7)
Very strong (VS)	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)
Fairly strong (FS)	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
Weak (W)	(2/3, 1, 3/2)	(2/3, 1, 2/2)
Equal (E)	(1, 1, 1)	(1, 1, 1)

- Fuzzy AHP Calculations: In this calculation, Fuzzy AHP uses the following stages (Chang, 1996):
  - Creating a pairwise comparison matrix with triangular fuzzy numbers
  - Determining the value of fuzzy synthesis (S_i):

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} \quad (3)$$

  - Fuzzy linguistic variables in triangular fuzzy numbers (TFN) are symbolized as M
  - Determining the degree of membership
  - Using a comparison of two fuzzy triangular numbers

$M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ with probabilities $M_2 \geq M_1$

$$V(M_2 \geq M_1) = \begin{cases} 1, & and if\ m_2 \geq m_1 \\ 0, & and if\ l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & Others \end{cases} \quad (4)$$

  - Determining the weighted Vector: If it is assumed that $d'(A_i) = \min V(S_i \geq S_k)\ for\ K = 1,2, \dots, n; k \neq 1$. Then vector weighted:

$$W' = (d(A_1), d(A_2), \dots, d(A_n))^T \quad (5)$$

  - Normalize the value of the fuzzy vector weight (w).

- Selecting Alternatives with Fuzzy TOPSIS: The alternative assessment for each criterion used a fuzzy scale which can be seen in Table 2. Then proceed with the calculation of Fuzzy TOPSIS with the following steps (Sun, 2010):

Step 1: Determine the weighting of the evaluation criteria. This study used fuzzy AHP to find initial preference weights.
Step 2: Creating of a fuzzy performance/decision matrix on alternatives for each criterion.
Step 3: Normalize the fuzzy decision matrix:

$$\tilde{R} = [\tilde{r}_{ij}]_{mxn}, i = 1,2,\dots,m; j = 1,2,\dots,n \quad (6)$$

$$\tilde{r}_{ij} = \left(\frac{l_{ij}}{u_j^+}, \frac{m_{ij}}{u_j^+}, \frac{u_{ij}}{u_j^+}\right), u_j^+ = \{u_{ij} | i = 1,2,\dots,n\} \quad (7)$$

Table 2: Fuzzy TOPSIS scale

Statement	Triangular Fuzzy Numbers
Very poor (VP)	(0, 0, 2)
Poor (P)	(1, 2, 3)
Medium poor (MP)	(2, 3.5, 5)
Fair (F)	(4, 5, 6)
Medium good (MG)	(5, 6.5, 8)
Good(G)	(7, 8, 9)
Very Good (VG)	(8, 10, 10)

The weighted fuzzy normalized decision matrix is shown as the following matrix $\tilde{V}$:

$$\tilde{V} = [\tilde{v}_{ij}]_{nxn,} \; i = 1,2,\dots,m; j = 1,2,\dots,n \quad (8)$$

where, $\tilde{v}_{ij} = \tilde{r}_{ij} \otimes \tilde{w}_j$.

Step 4: Determine the fuzzy ideal-positive solution (FPIS) and the fuzzy ideal-negative solution (FNIS):

$$A^+ = (\tilde{v}_1^*, \dots, \tilde{v}_i^*, \dots, \tilde{v}_n^*) \quad (9)$$

$$A^- = (\tilde{v}_1^-, \dots, \tilde{v}_j^-, \dots, \tilde{v}_n^-) \quad (10)$$

Step 5: Calculate the distance of each alternative:

$$\tilde{d}_i^+ = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^*), i = 1,2,\dots,m; j = 1,2,\dots,n \quad (11)$$

$$\tilde{d}_i^- = \sum_{j=1}^n d(\tilde{v}_{ij}, \tilde{v}_j^-), i = 1,2,\dots,m; j = 1,2,\dots,n \quad (12)$$

Step 6: Determining the proximity coefficient and rank the order of alternatives:

$$\widetilde{CC}_i = \frac{\tilde{d}_i^-}{\tilde{d}_i^+ + \tilde{d}_i^-} = 1 - \frac{\tilde{d}_i^-}{\tilde{d}_i^+ + \tilde{d}_i^-}, 1 = 1,2,\dots,m \quad (13)$$

3. Results and discussions

In this study, 3 experts performed pairwise comparisons against 6 criteria; Audience fit (C1), Reach (C2), Interactivity (C3), Cost (C4), Look and Feel (C5), and Frequency (C6). Pairwise comparison assessment used a fuzzy scale with triangular fuzzy numbers (TFN). The results of the comparison of these criteria can be seen in Table 3.

Prior to the analysis using Fuzzy AHP, the consistency calculation was carried out in pairwise comparisons against the criteria. The calculation of the Consistency Ratio (CR) was found to be 0.05. This value is smaller than 0.1, so it can be ascertained that the pairwise comparisons in this study are consistent.

The results of pairwise comparisons obtained opinions from 3 experts. To be able to combine the three assessments, a geometric mean calculation can be used. So that the three assessment results are then combined with the geometric mean and the results are 1 assessment for each comparison of criteria. The results of the geometric mean process are obtained in Table 4.

Table 3: Results of comparison between criteria

Criteria	Experts	C1	C2	C3	C4	C5	C6
C1	E1	(1,1,1)	(0.67,1,1.5)	(1.5,2,2.5)	(1.5,2,2.5)	(1.5,2,2.5)	(2.5,3,3.5)
	E2	(1,1,1)	(0.67,1,1.5)	(1.5,2,2.5)	(1.5,2,2.5)	(1.5,2,2.5)	(1.5,2,2.5)
	E3	(1,1,1)	(0.67,1,1.5)	(0.67,1,1.5)	(1.5,2,2.5)	(1.5,2,2.5)	(1.5,2,2.5)
C2	E1	(0.67,1, 1.5)	(1,1,1)	(0.67,1,1.5)	(1.5,2,2.5)	(1.5,2,2.5)	(1.5,2,2.5)
	E2	(0.67,1,1.5)	(1,1,1	(0.67,1,1.5)	(0.67,1,1.5)	(0.67,1,1.5)	(0.67,1,1.5)
	E3	(0.67,1,1.5)	(1,1,1)	(0.67,1,1.5)	(0.67,1,1.5)	(0.67,1,1.5)	(0.67,1,1.5)
C3	E1	(0.4,0.5,0.67)	(0.67,1,1.5)	(1,1,1)	(0.67,1,1.5)	(0.67,1,1.5)	(1.5,2,2.5)
	E2	(0.4,0.5,0.67)	(0.667,1,1.5)	(1,1,1)	(0.67,1,1.5)	(0.67,1,1.5)	(1.5,2,2.5)
	E3	(0.67,1,1.5)	(0.667,1,1.5)	(1,1,1)	(0.67,1,1.5)	(0.67,1,1.5)	(1.5,2,2.5)
C4	E1	(0.4,0.5,0.67)	(0.4,0.5,0.67)	(0.667,1,1.5)	(1,1,1)	(0.67,1,1.5)	(1.5,2,2.5)
	E2	(0.4,0.5,0.67)	(0.67,1,1.5)	(0.667,1,1.5)	(1,1,1)	(1,1,1)	(1.5,2,2.5)
	E3	(0.4,0.5,0.67)	(0.67,1,1.5)	(0.667,1,1.5)	(1,1,1)	(0.67,1,1.5)	(1.5,2,2.5)
C5	E1	(0.4,0.5,0.67)	(0.4,0.5,0.67)	(0.667,1,1.5)	(0.67,1,1.5)	(1,1,1)	(0.67,1,1.5)
	E2	(0.4,0.5,0.67)	(0.67,1,1.5)	(0.667,1,1.5)	(1,1,1)	(1,1,1)	(1,1,1)
	E3	(0.4,0.5,0.67)	(0.67,1,1.5)	(0.667,1,1.5)	(0.67,1,1.5)	(1,1,1)	(0.67,1,1.5)
C6	E1	(0.29,0.33,0.4)	(0.4,1,0.67)	(0.4,0.5,0.67)	(0.4,0.5,0.67)	(0.67,1,1.5)	(1,1,1)
	E2	(0.67,1,1.5)	(0.67,1,1.5)	(0.4,0.5,0.67)	(0.4,0.5,0.67)	(1,1,1)	(1,1,1)
	E3	(0.67,1,1.5)	(0.67,1,1.5)	(0.4,0.5,0.67)	(0.4,0.5,0.67)	(0.67,1,1.5)	(1,1,1)

Table 4: Result of geometric mean

Criteria	C1	C2	C3	C4	C5	C6
C1	(1,1,1)	(0.67,1,1.5)	(1.15,1.59,2.11)	(1.5,2,2.5)	(1.5,2,2.5)	(1.78,2.29,2.8)
C2	(0.67,1,1.5)	(1,1,1)	(0.67,1,1.5)	(0.87,1.26,1.78)	(0.87,1.26,1.78)	(0.87,1.26,1.78)
C3	(0.47,0.63,0.88)	(0.67,1,1.5)	(1,1,1)	(0.67,1,1.5)	(0.67,1,1.5)	(1.5,2,2.5)
C4	(0.4,0.5,0.67)	(0.56,0.80,1.15)	(0.67,1,1.5)	(1,1,1)	(0.76,1,1.31)	(1.5,2,2.5)
C5	(0.4,0.5,0.67)	(0.56,0.80,1.15)	(0.67,1,1.5)	(0.76,1,1.31)	(1,1,1)	(0.76,1,1.31)
C6	(0.36,0.44,0.56)	(0.56,1,1.15)	(0.4,0.5,0.67)	(0.4,0.5,0.67)	(0.76,1,1.31)	(1,1,1)

The next step in the fuzzy analysis is fuzzy synthesis. In this process, there are 3 numbers for each criterion which is a triangular fuzzy number scale. The results for these 6 criteria can be seen in Table 5. After obtaining the results of the fuzzy synthesis, the next step is to determine the degree of membership of the fuzzy number for each criterion. In this process, the fuzzy number will be converted into a single number. The results can be seen in Table 6. These results are then useful for the next process, namely normalization. The result of normalization is the value of the priority weight of the criteria which shows how important these criteria are for the selection of promotional media

which in this case is the promotion of tourist boats on the Mahakam River. The results of the priority weights for each criterion can be seen in Table 7.

In this study, the selected alternative advertising media consisted of 3 media, namely Social media (A1), Web (A2), and Mobile Application (A3). From the three alternatives, the selection is then made by considering the 6 criteria of Audience fit (C1), Reach (2), Interactivity (C3), Cost (C4), Look and Feel (C5), and Frequency (C6). To determine the weight of the criteria using Fuzzy AHP has been obtained which can be seen in Table 7. While for the alternative assessment of each criterion using Fuzzy TOPSIS.

Table 5: Result of fuzzy synthesis

Criteria	Fuzzy number
C1	(7.590,9.877,12.405)x(0.020,0.025,0.033)=(0.149,0.251,0.413)
C2	(4.954,6.780,9.335)x(0.020,0.025,0.033)=(0.097,0.172,0.311)
C3	(4.974,6.630,8.874)x(0.020,0.025,0.033)=(0.097,0.169,0.295)
C4	(4.892,6.294,8.122)x(0.020,0.025,0.033)=(0.096,0.160,0.270)
C5	(4.155,5.294,6.932)x(0.020,0.025,0.033)=(0.081,0.135,0.231)
C6	(3.483,4.437,5.351)x(0.020,0.025,0.033)=(0.068,0.113,0.178)

Table 6: Results of the degree of fuzzy membership function

Criteria	Value
C1	min(1,1,1,1,1)=1
C2	min(0.673,1,1,1,1)=0.673
C3	min(0.640,0.981,1,1,1)=0.640
C4	min(0.571,0.933,0.953,1,1)=0.571
C5	min(0.413,0.779,0.797,0.841,1)=0.413
C6	min(0.175,0.576,0.591,0.635,0.816)=0.175

Table 7: Result of priority weights for criteria

Criteria	W
Audience fit (C1)	0.288
Reach (C2)	0.194
Interactivity (C3)	0.184
Cost (C4)	0.165
Look and Feel (C5)	0.119
Frequency (C6)	0.050

The alternative assessment with Fuzzy TOPSIS is the same as the criteria assessment, using 3 experts, so combining these assessments requires additional calculations, namely the geometric mean. The results of the assessment of the 3 alternatives for the 6 criteria for the 3 experts can be seen in Table 8. While the results of combining 3 expert judgments into 1 can be seen in Table 9.

Table 8: Alternative assessment results

Criteria	Alternatives	E1	E2	E3
C1	A1	(7,8,9)	(7,8,9)	(8,10,10)
	A2	(7,8,9)	(7,8,9)	(7,8,9)
	A3	(7,8,9)	(7,8,9)	(5,6.5,8)
C2	A1	(7,8,9)	(7,8,9)	(7,8,9)
	A2	(4,5,6)	(7,8,9)	(4,5,6)
	A3	(4,5,6)	(4,5,6)	(4,5,6)
C3	A1	(7,8,9)	(8,10,10)	(8,10,10)
	A2	(7,8,9)	(5,6.5,8)	(7,8,9)
	A3	(5,6.5,8)	(7,8,9)	(7,8,9)
C4	A1	(5,6.5,8)	(4,5,6)	(4,5,6)
	A2	(4,5,6)	(4,5,6)	(2,3.5,5)
	A3	(4,5,6)	(2,3.5,5)	(4,5,6)
C5	A1	(7,8,9)	(7,8,9)	(7,8,9)
	A2	(5,6.5,8)	(7,8,9)	(5,6.5,8)
	A3	(5,6.5,8)	(7,8,9)	(7,8,9)
C6	A1	(7,8,9)	(7,8,9)	(4,5,6)
	A2	(4,5,6)	(5,6.5,8)	(7,8,9)
	A3	(4,5,6)	(5,6.5,8)	(4,5,6)

Table 9: Geometric mean results of alternative assessment

Criteria	A1	A2	A3
C1	(7.319,8.618,9.322)	(7,8,9)	(6.257,7.465,8.653)
C2	(7,8,9)	(4.820,5.848,6.868)	(4,5,6)
C3	(7.652,9.283,9.655)	(6.257,7.465,8.653)	(6.257,7.465,8.653)
C4	(4.309,5.457,6.604)	(3.175,4.440,5.646)	(3.175,4.440,5.646)
C5	(7,8,9)	(5.593,6.966,8.320)	(6.257,7.465,8.653)
C6	(5.809,6.840,7.862)	(5.192,6.383,7.560)	(4.309,5.457,6.604)

In this study, 6 criteria were used in the selection of tourism destination promotion media. To find out how important the criteria are, we use Fuzzy AHP and the results can be seen in Table 7. The most important criterion in this study is audience fit with a weight of 0.288. This shows that in the selection of

promotional media for the Mahakam tourist boat, the audience fit is the most important thing. This means that decision makers in choosing alternative existing promotional media, view the suitability of the audience as the most important thing. This result is similar to another study that selected suitable audience criteria as the main criterion, in the case of website selection for online advertising using AHP (Ngai, 2003). The audience fit criterion is whether the promotion is delivered to the right potential customers. In this case, the selection of promotional media considers the ability of the media used to convey to the right audience. Every promotion strategy needs to know its target audience. In order to concentrate their efforts and resources on prospective customers, marketing strategists must select one or more segments (priority audiences) (Lee and Kotler, 2019).

Another criterion is Reach. Reach (C2) has a weight value of 0.194, this criterion has the 2nd best value. It means that after audience fit (C1), the second most important criterion is Reach. The meaning of reach in this case is the ability of the promotional media to reach the audience. The use of media strategies can maximize reach and frequency, promotional messages can be targeted to reach as many audiences as possible (Lee and Kotler, 2019). The next criterion is Interactivity. In this criterion, the weight value is 0.184. This value has the 3rd largest value, which means Interactivity in this case is the third most important criterion after the 2 previous criteria. In this case, cost is not the first criterion for selecting promotional media. This can be seen from the priority weight with a value of 0.165, which means that it ranks 4th in the selection criteria for promotional media. The next criterion is Look and Feel (C5), with a priority weight value of 0.119. This weight value is in 5th place compared to 5 other criteria, so that makes this criterion the 5th most important in the selection of promotional media for the Mahakam river tour boat. The last criterion is frequency. The priority weight of this criterion is 0.050. It has the smallest value compared to the other criteria so this criterion has the last priority compared to the other criteria in this case.

The process of normalizing the matrix was carried out by using a scoring matrix that has been combined with the value of the weighting criteria obtained by the Fuzzy AHP process (Table 7), it can be seen in Table 10. The process of calculating the positive and negative ideal points for each criterion was carried out with the input from the previous step. The complete results of the process can be seen in Table 11. From the positive and negative points then each alternative and the criteria are calculated as the difference or distance (Table 12). From the distance results, the preference value for each alternative (Table 13) is obtained.

Table 10: Result of normalized fuzzy decision matrix with criteria weight

Criteria	A1	A2	A3
C1	(2.108,2.483,2.686)	(2.017,2.305,2.593)	(1.803,2.151,2.493)
C2	(1.357,1.550,1.744)	(0.934,1.133,1.331)	(0.775,0.969,1.163)
C3	(1.410,1.710,1.779)	(1.153,1.375,1.594)	(1.153,1.375,1.594)
C4	(0.709,0.898,1.087)	(0.523,0.731,0.929)	(0.523,0.731,0.929)
C5	(0.832,0.951,1.070)	(0.665,0.828,0.989)	(0.744,0.888,1.029)
C6	(0.292,0.344,0.396)	(0.261,0.321,0.381)	(0.217,0.275,0.332)

Table 11: Result of positive and negative ideal points for criteria

Criteria	P+	P-
C1	(2.686,2.686,2.686)	(1.803,1.803,1.803)
C2	(1.744,1.744,1.744)	(0.775,0.775,0.775)
C3	(1.779,1.779,1.779)	(1.153,1.153,1.153)
C4	(1.087,1.087,1.087)	(0.523,0.523,0.523)
C5	(1.070,1.070,1.070)	(0.665,0.665,0.665)
C6	(0.396,0.396,0.396)	(0.217,0.217,0.217)

Table 12: Distance to the ideal point

Criteria	d1+	d2+	d3+	d1-	d2-	d3-
C1	0.353	0.448	0.606	0.667	0.554	0.446
C2	0.250	0.632	0.791	0.791	0.393	0.250
C3	0.217	0.443	0.443	0.506	0.285	0.285
C4	0.244	0.396	0.396	0.406	0.264	0.264
C5	0.154	0.276	0.217	0.302	0.210	0.250
C6	0.067	0.089	0.130	0.134	0.115	0.075

Table 13: Preference value

Alternative	d*	d-	d*+d-	CC	Rank
Social Media (A1)	1.284	2.807	4.091	0.686	1
Web (A2)	2.284	1.821	4.105	0.444	2
Mobile Application (A3)	2.583	1.571	4.154	0.378	3

The preference value indicates the greater the preference value of an alternative, the better the alternative is compared to other alternatives. The preference value for the social media alternative is 0.686, this value is the largest value compared to other alternatives. Therefore, social media is the best alternative for promotional media in this case. The web is an alternative that has a value of 0.444. This value is the second largest value, so the web is in second place in the alternative ranking. The last

alternative, the Mobile Application has a value of 0.378. This value is the smallest among all the alternatives. It shows that the mobile application is an alternative with the 3rd rank.

A sensitivity analysis is performed to determine the sensitivity of this decision model. In this study, a sensitivity analysis was conducted by deleting one criterion and examining the findings of the alternate sequence to determine whether there was a change. Table 14 demonstrates that six sensitivity scenarios are unaffected by the removal of one criterion, hence it can be concluded that this model is not sensitive to this change. Thus, it can be stated that alternative A1 (Social media) dominates and remains the leading candidate in this election.

Table 14: Result of sensitivity analysis

Criteria deletion scenario	A1	A2	A3	Ranking
C1	0.691	0.420	0.372	A1>A2>A3
C2	0.660	0.460	0.434	A1>A2>A3
C3	0.697	0.457	0.370	A1>A2>A3
C4	0.697	0.454	0.374	A1>A2>A3
C5	0.689	0.441	0.358	A1>A2>A3
C6	0.690	0.438	0.378	A1>A2>A3

The results of this study provide something different from previous studies using a combination of Fuzzy AHP and Fuzzy TOPSIS (Nazim et al., 2022; Padma et al., 2022; Piya et al., 2022), and also different from previous studies regarding tourists who apply it to the hotel website evaluation case (Baki, 2020). The differences are shown in the application cases and some of the criteria used. Because this research applies the combination of FUZZY AHP and Fuzzy TOPSIS in selecting online tourism promotion media with a case study of tourist boats in Samarinda Indonesia. The application of this multi-criteria method combines several criteria with reference to previous research and adjustments to cases in the research object. In addition, the results of this study provide input for tourism objectives regarding the selection of online promotional media. There are limitations in this study, including social media in this study being general and not specific to the type of social media. This is due to the focus of this study comparing social media in general with other online promotion media such as web and mobile applications. So that comparing between types of social media is an interesting thing that can be done in further research.

4. Conclusion

This study has demonstrated the applicability of the combined approach of Fuzzy Analytic Hierarchy Process (AHP) and Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) in the selection of promotional media for the Mahakam river tour boat. By utilizing this method, both criteria and alternatives can be prioritized using fuzzy assessments. The findings indicate that the prioritized criteria, in descending order of importance, are Audience fit (C1), Reach (C2), Interactivity (C3), Cost (C4), Look and Feel (C5), and Frequency (C6). Regarding the optimal promotional media alternatives, social media, web, and mobile applications emerged as the most favorable choices. Consequently, leveraging social media for promotional purposes represents the most effective solution to enhance tourist visits to the Mahakam River tour boat.

In terms of future research directions, it is recommended to explore the expansion of this study by incorporating and comparing it with other multi-criteria methods. Additionally, a comparative analysis across various types of social media platforms could also provide valuable insights.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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