Journal of Information Systems Engineering and Management
2025, 10(45s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

An AHP-TOPSIS based Advertising Platform Selection Model

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ARTICLE INFO

Received: 18 Dec 2024

Revised: 10 Feb 2025

Accepted: 28 Feb 2025

ABSTRACT

The selection of an appropriate advertising platform, based on personalized preferences, is considered as a multiple criteria decision-making (MCDM) problem which involves assessment of a set of advertising platforms (alternatives) in terms of preferences (decision criteria). This study proposes a MCDM model to determine optimal advertising platform. The Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) are integrated to determine the best decision alternative under MCDM environment. The developed model is applied to a case study, which considers a decision matrix established with 11 advertisement platforms (decision alternative) dominating each-other based on their 7 attributes (decision criteria). The relative weights of all criteria are determined, which are then supplied to TOPSIS methodology to rank the advertisement platforms.

Keywords: Advertising Platform Selection, AHP, TOPSIS, MCDM, Decision Making.

INTRODUCTION

In today's digital age, businesses have a plethora of platforms to advertise their products and services (Javan, Khanlari, Motamedi & Mokhtari, 2018; Mukul, Büyüközkan & Güler, 2019). From traditional mediums like print and television to modern digital channels like social media, search engines, websites, the advertising options are vast and diverse (Dahooie, Estiri, Janmohammadi, Zavadskas & Turskis, 2022). With so many platforms available, businesses can now tailor their advertising strategies to suit their specific needs and goals. However, selecting the optimal advertising platform is a complex process, as it involves multiple alternatives dominating each other based on different criteria (Tafreshi, Aghdaie, Behzadian & Abadi, 2016). For instance, social media may excel in terms of reach and engagement, while search engines may outperform in terms of conversion rates. Furthermore, the vast array of different criteria, including target audience and budget, adds to the challenge (Dahooie et al., 2022).

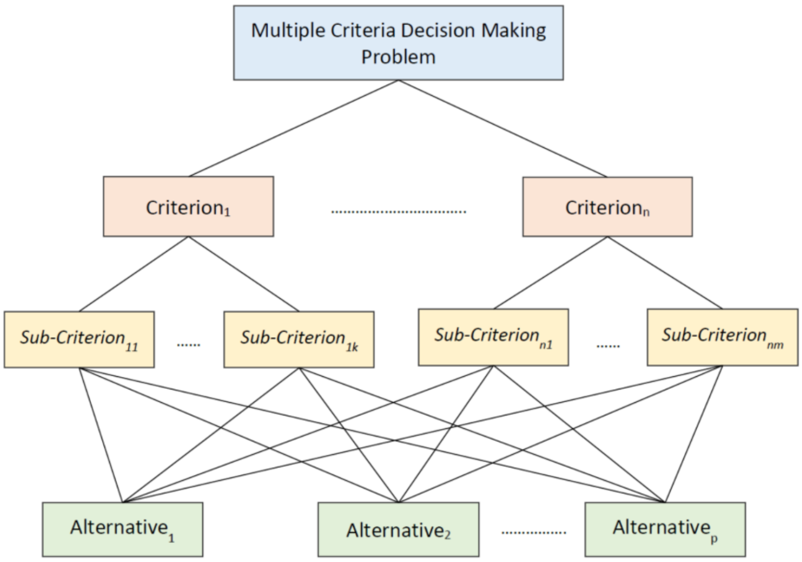

Figure 1: Architecture of a MCDM Problem

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Journal of Information Systems Engineering and Management
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Therefore, the selection of an appropriate advertising platform can be considered as a multiple criteria decision-making (MCDM) problem (Hwang & Yoon, 1981), as shown in Figure 1, which deals with assessment of a set of advertising platforms (alternatives) in terms of business-specific personalized preferences (decision criteria).

The Analytic Hierarchy Process (AHP) (Saaty, 1980) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) (Hwang & Yoon, 1981) are powerful tools widely used for solving MCDM problems [7] [8] [9] [10] [11] (Arya & Pal, 2025; Govindaraju & Sreenath, 2025; Murty & Rao, 2025; Patil & Singh, 2023; Suman, Sonia, Jasrotia & Singh, 2023, Singh & Singh, 2018).

This paper utilizes AHP and TOPSIS to develop a decision support model to assist in selecting appropriate advertising platform based on business-specific personalized preferences. The rest part of this paper is structures as follows: Section II describes the theoretical background of MCDM problem, AHP and TOPSIS; Section III reports the phases of the proposed model; Section IV describe the use of proposed model for assisting in selection of best advertising platform (as a case study); finally, Section V concludes the paper with future research work.

THEORETICAL BACKGROUND

Multiple Criteria Decision-Making Problem

Under MCDM, the decision-making process can be facilitated by expressing the problem in a matrix form which consists of rows representing the alternatives and columns representing the criteria. The following matrix expresses the MCDM problem:

$$
\begin{array}{c|cccc|}
 & C_1 & C_2 & \cdots & C_n \\
\hline
A_1 & a_{11} & a_{12} & \cdots & a_{1n} \\
A_2 & a_{21} & a_{22} & \cdots & a_{2n} \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
A_m & a_{m1} & a_{m2} & \cdots & a_{mn} \\
\hline
 & w_1 & w_2 & \cdots & w_n
\end{array}
$$

where,

$A = \{A_i \mid i = 1, \dots, m\}$ represents the set of decision alternatives,

$C = \{C_j \mid j = 1, 2, \dots, n\}$ represents to the set of decision criteria,

a_{ij} (i = 1, 2, .., m and j = 1, 2, .., n) represents the assessment score of i^{th} decision alternative over j^{th} decision criterion, and

w_j (j = 1, 2, .., n) represents to the weight of criterion C_j.

The problem is to find the best alternative with highest degree of desirability with respect to criteria.

Analytic Hierarchy Process (AHP)

AHP, proposed by Saaty (1980), is a mathematical method to solve MCDM problem. It aids decision-makers in determining the weight (relative importance) of each criterion through pairwise comparison assessments. The following process is followed to determine the relative importance of criteria (Saaty, 1980):

(a) Using Saaty's 9-point scale, subjectively evaluate each pair of criteria to create a pairwise comparison matrix $[x_{ij}]_{m\times n}$, where x_{ij} indicates the relative importance of criterion i to j; $x_{ji} = 1/x_{ij}$; $x_{ij} = 1$, if $i = j$.

(b) Applying the eigenvalue calculation framework to $[x_{ij}]_{m\times n}$ matrix to determine the relative weight of each criterion.

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e-ISSN: 2468-4376
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(c) By adhering to the concept of consistency index/ratio, check the consistency of subjective perception in pairwise comparisons.

AHP and TOPSIS are often integrated to leverage their strengths in multi-criteria decision-making. AHP excels at determining the relative importance (weights) of different criteria through pairwise comparisons, while TOPSIS excels at ranking alternatives based on their closeness to an ideal solution. By integrating these methods, decision-makers can get a more objective and informed judgment.

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS, developed by Hwang and Yoon (1981), solves the MCDM problem based on the concept that the selected alternative should have the smallest distance to the positive ideal solution and the longest distance from the negative ideal solution. The positive ideal solution optimizes functionality while minimizing cost, whereas the negative ideal solution maximizes cost while minimizing functionality. The detailed procedure of TOPSIS can be found in the study done by Hwang and Yoon (1981). In recent literature, TOPSIS has been applied to solve decision-making problems of various domains (Aggarwal, Sharma, Kukreja, Verma & Aggarwal, 2025; Saoud et al., 2025; Tarafdar, Shaikh, Ali & Haldar, 2025; Han, Alkhawaji & Shafieezadeh, 2025).

PROPOSED MODEL

The proposed model for multiple criteria decision-making combines AHP (to compute relative relevance of various factors of advertisement platforms) and TOPSIS (to rank the advertisement platforms based upon decision-maker's preferences. The methodological steps of the proposed model, illustrated in Figure 2, are detailed below.

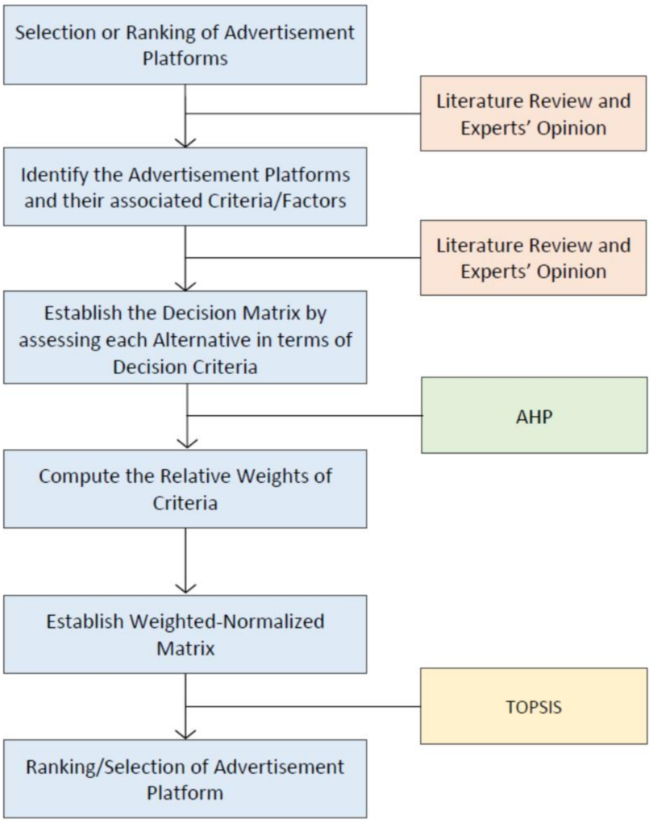

Figure 2: Methodological Steps of the Proposed Model

(a) Identify the available advertisement platform (decision alternatives) and their associated attributes (criteria).

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(b) Assess each identified advertisement platform in terms of various criteria and establish a decision matrix $[a_{ij}]_{m\times n}$, where m indicates number of decision alternatives and n indicates number of decision criteria.

(c) Compute the relative weights of criteria ($w_j, j = 1, 2, \dots, n$) through eigenvalue calculation framework of AHP.

(d) Establish a weighted normalized matrix $[p_{ij}]_{m\times n}$, where $p_{ij} = r_{ij} \times w_j$ and $r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} a_{ij}^2}}$.

(e) Apply TOPSIS procedure to $[p_{ij}]_{m\times n}$ matrix for ranking the decision alternatives.

SELECTION OF BEST ADVERTISING PLATFORM (CASE STUDY)

The process of selecting the best advertising platform (based on personalized preferences) from several options is complex because each advertising platform dominates each other in different characteristics, and, therefore, requires a decision-support model in the selection process. The following steps of the proposed decision-support model facilitate the decision-maker in selecting the optimal advertising platform according to individualized preferences.

(a) Identify the available advertisement platform (decision alternatives) and their associated attributes (criteria).

The literature (Alavijeh, Foroozan & Afrashteh, 2019; Azkeskin, Bozdemir & Alkan, 2023; Bist, 2024; Coulter & Sarkis, 2005; Faisal & Khan, 2008; Indrayana & Utomo, 2022; Javan et al., 2018; Ngai, 2003; Nimcj, 2024; Saen, 2011; Sudipa et al., 2020; Tafreshi et al., 2016; Tavana, Momeni, Rezaeiniya, Mirhedayatian & Rezaeiniya, 2013) was reviewed and opinion of two ad experts was considered to explore the available ad platforms and their associated attributes. This process resulted in identification of the eleven commonly used advertisement platforms (A_1: Television, A_2: YouTube, A_3: Social Networking Sites, A_4: WhatsApp, A_5: Radio and Podcast, A_6: Billboard, A_7: Newspaper and Magazine, A_8: Email, A_9: Phone and SMS, A_{10}: Internet Websites, A_{11}: Transit Advertisement) with their seven main characteristics (C_1: Rich Content Support, C_2: Cost of Advertisement, C_3: Precise Targeting, C_4: Reach and Coverage, C_5: Frequency and Timing, C_6: Rating and Feedback, C_7: Exposure Time). Mathematically, $m = 11$ and $n = 7$.

(b) Assessment of each identified advertisement platform in terms of various criteria and establish a decision matrix $[a_{ij}]_{m\times n}$.

Table 1 presents a decision matrix $[a_{ij}]_{7\times 7}$, which is constructed based on the performance assessment of each ad platform on the seven criteria. The experts' opinion and literature [25] [26] helped in formation of the matrix with linguistic terms, which can be defined as: VH = Very High, H = High, M = Medium, L = Low, and VL = Very Low. In general, the conversion of linguistic terms to their corresponding numerical terms is done using fuzzy set approach (Bonissone, 1980). However, this study assumes numerical values '1', '2', '3', '4' and '5' to their corresponding 'Very Low', 'Low', 'Medium', 'High' and 'Very High' score, which may have deficiencies because of non-consideration of fuzziness.

Table 1: Decision Matrix (Performance Assessment of Ad Platforms on Criteria)

Ad Platform	Rich Content Support	Cost of Advertisement	Precise Targeting	Reach and Coverage	Frequency and Timing	Rating and Feedback	Exposure Time
Television	VH	VH	VL	H	VH	VL	L
YouTube	VH	M	H	VH	VH	VH	H
Social Networking Sites	VH	M	VH	VH	VH	VH	VH
WhatsApp	VH	M	L	VH	VH	VH	VH
Radio and Podcast	M	H	L	VH	VH	VL	M

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Journal of Information Systems Engineering and Management
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e-ISSN: 2468-4376
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Ad Platform	Rich Content Support	Cost of Advertisement	Precise Targeting	Reach and Coverage	Frequency and Timing	Rating and Feedback	Exposure Time
Billboard	L	L	M	VL	VH	VL	L
Newspaper and Magazine	M	H	L	H	L	VL	L
Email	VH	L	M	L	H	M	M
Phone and SMS	L	L	M	VH	M	H	M
Internet Websites	H	M	M	M	H	H	VH
Transit Advertisement	M	L	M	VL	H	VL	VL

(c) Computation of the relative weights of criteria using AHP.

To determine the relative weights of each criterion, criteria are compared pairwise (based on preferences of the decision-maker) with Saaty's 9-point scale (Saaty, 1980) which results in the comparison matrix given in Table 2.

Table 2: Pairwise Comparison Matrix

Criterion	C_1	C_2	C_3	C_4	C_5	C_6	C_7
C_1	1	2	5	4	4	6	9
C_2	1/2	1	4	5	4	5	5
C_3	1/5	1/4	1	4	4	5	5
C_4	1/4	1/5	1/4	1	1	2	4
C_5	1/4	1/4	1/4	1	1	2	5
C_6	1/6	1/5	1/5	1/2	1/2	1	2
C_7	1/7	1/5	1/5	1/4	1/5	1/2	1

The pairwise comparison matrix, given in Table 2, is processed to calculate relative weight of each criterion (w_j) using AHP framework [6], which results in criteria weights shown in Table 3 (with consistency ratio 0.07).

Table 3: Criteria Weights

Criterion	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Weight	0.36	0.27	0.16	0.07	0.07	0.04	0.03

(d) Establish a weighted normalized matrix $[p_{ij}]_{m\times n}$, *where* $p_{ij} = r_{ij} \times w_j$ *and* $r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^{m} a_{ij}^2}}$.

Under this step, a weighted normalized matrix, presented in Table 4, is established using decision matrix (Table 1) and criteria weights (Table 3).

Table 4: Weighted Normalized Matrix

Ad Platform	C_1	C_2	C_3	C_4	C_5	C_6	C_7
A_1	0.136	0.129	0.016	0.021	0.024	0.004	0.005
A_2	0.136	0.078	0.064	0.027	0.024	0.018	0.010
A_3	0.136	0.078	0.080	0.027	0.024	0.018	0.013
A_4	0.136	0.078	0.032	0.027	0.024	0.018	0.013
A_5	0.081	0.103	0.032	0.027	0.024	0.004	0.008
A_6	0.054	0.052	0.048	0.005	0.024	0.004	0.005
A_7	0.081	0.103	0.032	0.021	0.010	0.004	0.005

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Journal of Information Systems Engineering and Management
2025, 10(45s)
e-ISSN: 2468-4376
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A_8	0.136	0.052	0.048	0.011	0.019	0.011	0.008
A_9	0.054	0.052	0.048	0.027	0.014	0.015	0.008
A_{10}	0.109	0.078	0.048	0.016	0.019	0.015	0.013
A_{11}	0.081	0.052	0.048	0.005	0.019	0.004	0.003

(e) Apply TOPSIS procedure to $[p_{ij}]_{m\times n}$ matrix for ranking the ad platforms.

This phase begins with calculation of positive-ideal solution (A^+) and negative-ideal solution (A^-). A^+ is the one that maximizes the benefit criteria and minimizes the cost criteria, while the A^- maximizes the cost criteria and minimizes the benefit criteria.

A^+ and A^- are determined using Equation (1) and (2), respectively, as follows:

$$A^+ = (v_1^+, v_2^+, v_3^+, \ldots, v_n^+) = \left(\left(\max_i v_{ij} \mid j \in I\right), \left(\min_i v_{ij} \mid j \in J\right)\right) \quad (1)$$

$$A^- = (v_1^-, v_2^-, v_3^-, \ldots, v_n^-) = \left(\left(\min_i v_{ij} \mid j \in I\right), \left(\max_i v_{ij} \mid j \in J\right)\right) \quad (2)$$

where, I represents benefit criteria and J represents cost criteria. In this study, c_2 and c_7 are cost criteria while all other remaining criteria are benefit criteria.

Table 5 shows values of A^+ and A^- for all seven criteria.

Table 5: Values of A^+ and A^-

A^+	0.136	0.052	0.080	0.027	0.024	0.018	0.003
A^-	0.054	0.129	0.016	0.005	0.010	0.004	0.013

In next step, separation of each decision alternative (advertisement platforms) from A^+ and A^-, represented as D_i^+ and D_i^- are calculated using Equation (3) and (4), respectively.

$$D_i^+ = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^+)^2}, i = 1, 2, 3, \ldots, m \quad (3)$$

$$D_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^-)^2}, i = 1, 2, 3, \ldots, m \quad (4)$$

Finally, the relative closeness of the i^{th} alternative with respect to A^+ is determined using Equation (5).

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (5)$$

Table 6 shows the values of D_i^+, D_i^- and C_i. Based on the closeness to the ideal solution, the advertisement platforms are ranked, which indicates that 'Social Networking Sites' is determined as the best platform for advertisement based on the personalized preferences of the decision-maker.

Table 6: Details of Relative Closeness and Ranks

Ad Platform	D_i^+	D_i^-	C_i	Rank
A_1	0.102	0.085	0.453	9
A_2	0.031	0.112	0.781	2
A_3	0.028	0.120	0.811	1
A_4	0.056	0.102	0.647	4
A_5	0.090	0.049	0.349	10

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Journal of Information Systems Engineering and Management
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e-ISSN: 2468-4376
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A_6	0.091	0.086	0.484	8
A_7	0.092	0.045	0.327	11
A_8	0.037	0.118	0.759	3
A_9	0.088	0.088	0.498	7
A_{10}	0.052	0.084	0.617	5
A_{11}	0.068	0.089	0.567	6

CONCLUSION

An AHP and TOPSIS based decision-support model is developed to determine the best decision alternative under MCDM environment. The developed model is applied to a case study of selecting best advertisement platform based on personalized preferences of decision-maker. The study considers a decision matrix established with 11 advertisement platforms (decision alternative) dominating each-other based on their 7 attributes (decision criteria). Using AHP, the relative weights (importance) of all criteria are determined, which are then supplied to TOPSIS methodology to rank the advertisement platforms. The model determined 'social networking sites' as the best advertisement platform based on the personalized preferences of the decision-maker. This research has some shortcomings due to the fact that it is based on the perceptions of decision makers, discrete scale (1 to 9) for pairwise comparisons, and linguistic assessment ("Very Low' to "Very Good') for the performance evaluation, which fails to address the uncertainty and ambiguity inherent in decision-making processes. To address the uncertainty and ambiguity, fuzzy logic may be augmented in the developed model.

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