MANAGEMENT
2025, Vol. 29, No. 2
www.management-poland.com
DOI: 10.58691/man/216708

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Enhancing Digital Marketing Through Optimized CRM Selection: A Fuzzy AHP-TOPSIS Perspective

Abstract

Research background and purpose: Selecting an appropriate CRM platform is a critical yet complex decision for organizations aiming to optimize digital marketing effectiveness. This complexity arises from diverse functional requirements, cost considerations, and market uncertainty. The purpose of this research is to provide a systematic, objective method for evaluating CRM alternatives to mitigate the risks of manual or biased selection processes.

Design/methodology/approach: The study introduces an integrated multi-criteria decision-making (MCDM) approach. It combines Fuzzy Analytic Hierarchy Process (Fuzzy AHP), used to determine the relative importance of evaluation criteria, with the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), which ranks the alternatives. The methodology was validated through a real-world case study at Test Mentor Co., Ltd., involving a sensitivity analysis across 45 different scenarios to ensure results were robust.

Findings: The results identify HubSpot CRM as the most suitable platform for the case study, followed by Zoho CRM and Salesforce CRM, while Microsoft Dynamics CRM ranked the lowest. Additionally, the study reveals that subscription cost and reporting capabilities are the most influential criteria driving the selection process in this context.

Value added and limitations: This research adds value by offering a data-driven, repeatable framework that transforms qualitative requirements into quantitative rankings, providing actionable insights for businesses. While the sensitivity analysis confirms the robustness of the findings for the specific case study, a primary limitation is that the rankings may shift based on the unique strategic priorities or budget constraints of different organizational environments.

Keywords: *TOPSIS, soft computing, CRM, Fuzzy AHP, digital marketing*

JEL Classification: C44

Received: 2025-10-29; **Revised:** 2025-12-15; **Accepted:** 2026-01-09

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1. Introduction

In today's rapidly evolving digital landscape, driven by Industry 4.0 advancements, a robust Customer Relationship Management (CRM) system has become indispensable for businesses aiming to leverage data, enhance digital marketing activities, and ultimately boost sales and customer satisfaction. However, the critical task of selecting the optimal CRM platform presents a significant challenge. Businesses must meticulously balance a multitude of factors, including intricate functional and technical requirements, alongside crucial cost considerations. The current market is flooded with diverse CRM solutions, varying widely in features and pricing, making it arduous for organizations to pinpoint the ideal fit for their unique operational needs. Compounding this complexity, the successful adoption of a CRM platform is heavily reliant on the proficiency of the personnel utilizing it. This necessitates careful consideration of technical aspects and the development of a comprehensive implementation strategy to ensure operational efficiency.

The sobering reality is that a significant number of CRM implementation projects fall short of their anticipated outcomes. Traditional, independent methods for CRM selection, such as the Analytic Hierarchy Process (AHP), often suffer from a significant drawback: subjectivity on the part of the decision-maker. To mitigate this limitation, recent research has increasingly turned to integrated multi-criteria decision-making (MCDM) approaches within a fuzzy environment. The incorporation of fuzzy logic effectively addresses ambiguities and uncertainties inherent in complex data, thereby reducing evaluator bias. This shift towards more sophisticated methodologies is crucial for making informed and objective decisions in complex technological selections.

To support managerial decision-making in selecting the most appropriate CRM platform for enhancing digital marketing performance, this study introduces an integrated multi-criteria decision-making approach. Specifically, the methodology combines the Fuzzy Analytic Hierarchy Process (Fuzzy AHP) with the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). Fuzzy AHP is utilized to determine the relative weights of evaluation criteria under uncertainty, while TOPSIS ranks the CRM alternatives based on their proximity to the ideal solution. The proposed framework is applied to a real-world case study at Test Mentor Co., Ltd., providing practical insights into CRM selection. By systematically addressing the complexity of this decision-making process, the integrated Fuzzy AHP–TOPSIS approach ensures a more objective and robust evaluation compared to traditional methods. Although this hybrid technique has been successfully implemented in various domains, to the best of our knowledge, this research represents the first application of Fuzzy AHP–TOPSIS specifically for CRM platform selection aimed at improving digital marketing effectiveness.

The primary objective of this study is to leverage an integrated Fuzzy AHP-TOPSIS methodology for the comprehensive selection of CRM platforms. To achieve this, the key criteria and sub-criteria considered by Test Mentor Co., Ltd. in the CRM platform selection process will first be identified. Subsequently, valuable insights will be gathered from company stakeholders, including managers and marketing staff, regarding their needs and perspectives on CRM platform selection. Finally, the identified criteria and sub-criteria will be evaluated based on stakeholder insights, and the integrated Fuzzy AHP-TOPSIS model will be applied to assess and rank the CRM platforms, providing a data-driven recommendation. This research focuses specifically on integrating the Fuzzy AHP-TOPSIS method into the assessment and selection of a CRM platform to improve digital marketing effectiveness. This will involve in-depth interviews with a panel of experts and stakeholders from Test Mentor Co., Ltd. who possess extensive experience in Customer Relationship Management and digital marketing. The data gathered from these interviews will serve as the input for the integrated Fuzzy AHP-TOPSIS model. The ultimate findings and recommendations from this study are designed to be broadly applicable, offering valuable insights for other businesses in their own CRM platform selection processes, thereby contributing to improved operational efficiency and optimized business objectives across various industries.

2. Related works

According to (Kincaid, 2003), CRM is a strategic tool that helps businesses manage relationships with customers effectively. This tool uses information, processes, and technology to support relevant departments within the company such as marketing, sales and customer support throughout the customer lifecycle. CRM systems will help businesses collect and analyze customer data from many angles, thereby better understanding their needs and behaviors (Chang, 2007). According to Kalakota & Robinson (2001), CRM is a strategy that integrates marketing, sales, and service to avoid operating independently and that depends on the coordination of activities across the enterprise. In general, CRM is a business strategy that focuses on maintaining current customers and attracting new customers to enhance the competitive advantage of businesses. Nowadays, CRM is often referred to as CRM software. This is a tool that acts as a single repository to integrate your sales, marketing, and customer support activities. This software helps to enhance digital marketing activities, optimize processes and human resources on a single platform. Companies can use IT tools and CRM software packages to save information about their customers and adjust relationships with them (Nguyen & Mutum, 2012). CRM

software packages also include functions that allow them to make better marketing plans and manage available budget allocation.

Over the years, many businesses have implemented CRM packages to enhance customer satisfaction and loyalty, thereby improving business profits. However, there are many companies that deploy a CRM system but still do not fully understand the impact of the CRM system on business operations and evaluate the compatibility of that CRM platform with the overall goals and strategy of the organization (Battor, 2010). Choosing the wrong CRM platform leads to unnecessary waste of time and costs. Evaluating and selecting between alternatives based on a variety of criteria requires careful consideration. Methods such as Multi-Criteria Decision Analysis (MCDM), Analytical Hierarchy Process (AHP), and Fuzzy Analytical Hierarchy Process (FAHP) have been developed to address this challenge.

Table 1. **The summary of some articles using related decision-making methods**

Source/ Author(s)	Research methods applied	Application/ Case study
Hanine, Boutkhoum, Tikniouine, & Agouti, 2016	AHP-TOPSIS methodology	ETL software selection
Lim, Ariffin, Ali, & Chang, 2021	AHP and TOPSIS	Live-streamer selection
Muradi, 2022	Fuzzy AHP-TOPSIS	Blockchain platforms selection
Contreras-Masse, Ochoa-Zezzatti, García, Pérez-Dominguez, & Elizondo-Cortés, 2020	TOPSIS, AHP Methods	IoT Platforms selection
Rajak, 2019	AHP and Fuzzy TOPSIS	Evaluate and select Mobile Health applications
Cricelli, Grimaldi, & Hanandi, 2014	Analytic hierarchy process method	Information systems selection
Lněnička, 2015	AHP methodology	Analytic Platforms selection
Sun, 2010	Fuzzy AHP-TOPSIS	Performance evaluation
Ayda, Prisa, & Mohammad, 2017	Fuzzy AHP and Fuzzy TOPSIS	Ranking and selection of Chief Banking Inspector
Venkatesh, Zhang, Deakins, Luthra, & Mangla, 2018	Fuzzy AHP-TOPSIS	Supplier partner selection

Source: own study

With the transition from the traditional economy and increasing competition in new dimensions, customers are becoming one of the main driving forces of business activity. Choosing a good CRM platform will help businesses optimize marketing efficiency and increase competitive advantage in the new economic environment. To the best of my knowledge, there is a lack of research on assessing and selecting of CRM platforms to enhance digital marketing by using the Fuzzy AHP-TOPSIS approach for the author to develop a decision-making model effective determination in uncertain environments. According to the author's knowledge, currently no one has researched this topic using the Fuzzy AHP - TOPSIS integrated method.

3. Methods

This section divides the proposed method into three main steps: In the first stage, identify main criteria, sub-criteria and alternatives by interviewing and presenting them to experts for consideration. In the next stage, specialists evaluate the relative importance of each pair of criteria as well as the relative performance of the alternatives.

3.1. Research process

In this article, the triangular fuzzy numerical method is applied to construct a fuzzy decision matrix throughout the process of collecting and synthesizing information for decision making (Figure 1). Triangular fuzzy numbers play a role in supporting decision makers in evaluating, comparing criterion and choosing optimal solutions in uncertain and ambiguous environments. Finally, the distance between the alternatives is calculated to give the results.

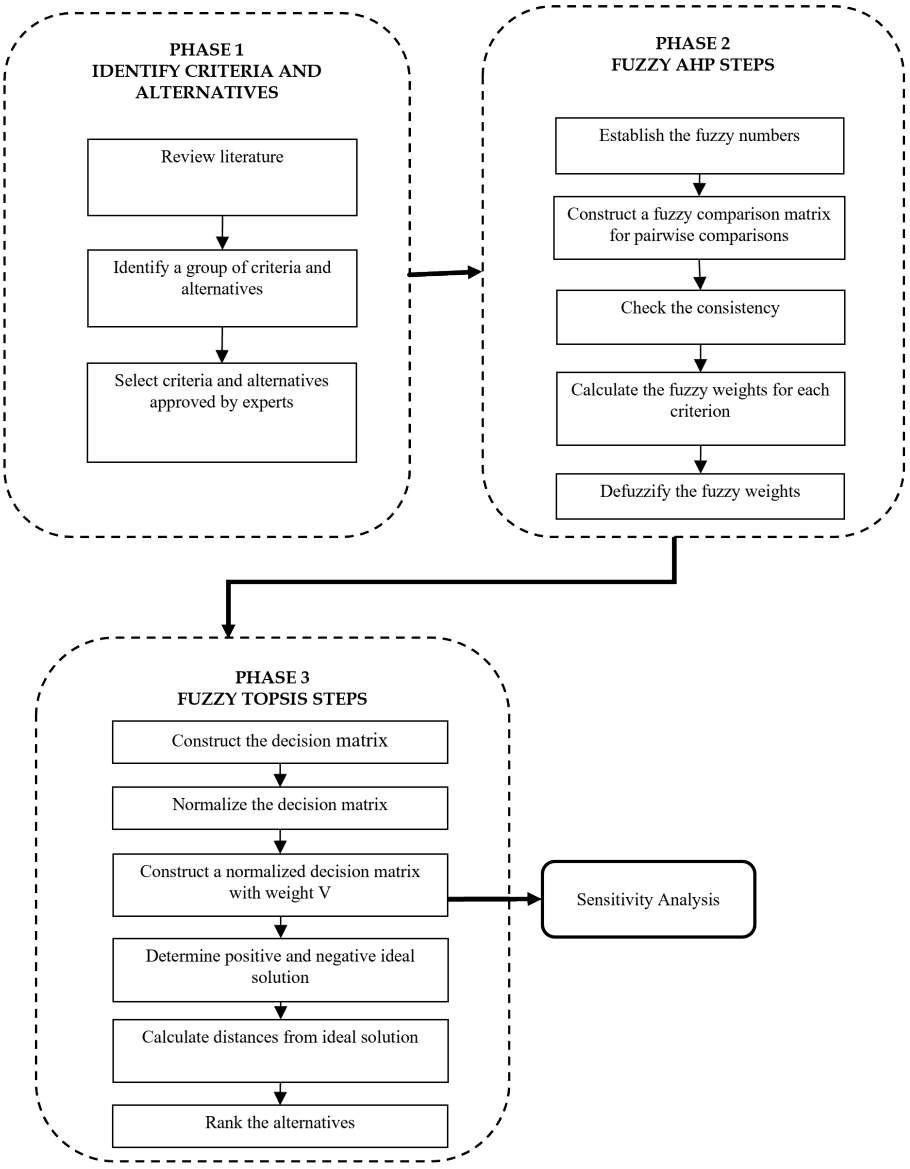

Figure 1. **Research process**

Source: own study

3.2. The proposed method

3.2.1. Criteria and alternatives determination

Evaluation and selection of the best CRM platform is the main objective of this study and a multi-criteria approach to decision making is used. The study identified main-criteria and sub-criteria for CRM platform selection based on a thorough review of relevant literature. In particular, the main evaluation criteria are technical criteria, functional criteria and cost criteria for implementing the CRM platform. Effectiveness of digital marketing through CRM implementation at Test Mentor Co., Ltd is assessed using the Fuzzy TOPSIS technique, allowing for decision-making in uncertain, ambiguous environments and handles inconsistent decision-making situations. Conclusion of the study can provide insight for other businesses looking to choose or evaluate the effectiveness of the CRM platform, especially in improving the effectiveness of Digital Marketing activities. To specify the goals, this study proposed 3 main criteria and 10 sub-criteria to assess and select the appropriate CRM platform (Table 2):

1. ***Functional criteria (C1):*** Functional criteria are one of the important criteria that businesses need to consider during the process of assessing and choosing a CRM platform. The function of a CRM platform is to identify and categorize the services it can provide, ensuring that features are integrated appropriately with the specific work processes of the organization using it (Adebanjo, 2003). This criterion includes 3 sub-criteria: Leads and contacts management (C11), Email Marketing (C12), Track reporting (C13).
2. ***Technical criteria (C2):*** Technical criteria are important criteria in evaluating and choosing suitable CRM software. It includes software and hardware related elements of CRM technology (Alshawi, Missi, & Irani, 2011). This criterion includes 4 sub-criteria: Usability (C21), Scalability (C22), Integration (C23) and Performance (C24).
3. ***Cost criteria (C3):*** Cost is an important criterion in selecting a CRM platform which includes all the costs that businesses must pay to buy, deploy and maintain a CRM system. It is important to consider the cost factor because the actual cost of implementation is often higher than the initial purchase price (Goldenberg, 1991). Therefore, Goldenberg emphasized the need to fully understand this criterion, not only the number shown but also considering whether the price includes upgrade costs and support costs. This criterion includes 3 sub-criteria: Subscription costs (C31), Training and support costs (C32), Maintenance and upgrade costs (C33).

Table 2. **The summary of criteria for evaluating and selecting CRM platforms**

Criteria	Sub-criteria	Description	Sources
Functional criteria (C1)	Leads and contacts management (C11)	Store and manage detailed customer information including name, address, email, phone number, purchase history, preferences, needs, etc. Classifying customers by groups and segments for easy management, helps find customer information quickly and easily	Oyekola & Xu, 2020 Friedrich & Breitner, 2012
	Email Marketing (C12)	Support businesses in managing and implementing effective Digital Marketing activities. This includes sending regular emails and news to customers and monitoring their feedback	Oyekola & Xu, 2020
	Track reporting (C13)	Enable measure and track effective with detailed reports on performance, trends, and enable data management and export them to office programs	Hasan, 2020
Technical criteria (C2)	Usability (C21)	"Usability" represents the extent to which the functions and features of open source CRM software meet the needs and desires of businesses in enhancing business marketing activities. As mentioned above, the level of meeting user needs is considered an important criterion in evaluating software quality according to the model	Lien & Liang, 2005 Karlsson, Wohlin, & Regnell, 1998
	Scalability (C22)	Scalability is a key factor that helps CRM systems meet the constantly evolving needs of businesses. It is capable of helping the system handle large amounts of data and support an increased number of users	Friedrich & Breitner, 2012
	Integration (C23)	The CRM system has the ability to integrate and synchronize with many other applications and systems. Tools and services that can be integrated include: email marketing tools, digital marketing platforms as well as management software inventory and order processing	Friedrich & Breitner, 2012
	Performance (C24)	Including data processing capabilities, fast response time to user operations etc., ensuring a smooth and uninterrupted experience	Friedrich & Breitner, 2012
Cost criteria (C3)	Subscription cost (C31)	That is the cost of using CRM software, which can be paid monthly or annually. Pricing will vary depending on the provider, number of users, and features selected	Oyekola & Xu, 2020
	Training and support cost (C32)	Cost of training employees on how to use CRM software and support costs after CRM implementation. Depending on the size of the business and the level of training needed, there will be different costs	Hong & Kim, 2007
	Maintenance and upgrades cost (C33)	The costs of keeping CRM software up to date and running efficiently such as feature updates and infrastructure maintenance, etc.	Jadhav & Sonar, 2011 Hong & Kim, 2007

Source: own study

The evaluation in this study focuses on four widely recognized and reputable CRM platforms: HubSpot CRM, Salesforce CRM, Zoho CRM, and Microsoft Dynamics CRM. Each platform offers distinct strengths; HubSpot is crucial for digital marketing campaigns, Salesforce provides comprehensive sales, management, and customer care support, Zoho unifies sales, marketing, and support online, and Microsoft Dynamics excels at strengthening customer relationships across sales, marketing, and service. The assessment of these alternatives requires expert knowledge and experience with each of these established systems.

3.2.2 Hierarchical structure

The author proposes a hierarchical model with the goal of assessing and selecting CRM platforms with 3 main criteria and 10 sub-criteria (Figure 2):

1. ***Functional criteria (C1):*** This primary criterion includes 3 sub-criteria: Leads and Contacts Management (C11), Email Marketing (C12) and Tracking Reporting (C13),
2. ***Technical criteria (C2):*** This main criterion includes 4 sub-criteria: Usability (C21), Scalability (C22), Integration (C23) and Performance (C24),
3. ***Cost criteria (C3):*** Includes 3 sub-criteria: Registration costs (C31), Training and support costs (C32) and Maintenance and upgrade costs (C33).

3.2.3. Fuzzy AHP

Step 1. Selecting the right software requires balancing multiple competing priorities. To facilitate this, we will construct a hierarchy structure. A hierarchy of criteria is created to evaluate CRM platforms as the above figure.

Step 2. Build a pairwise comparison matrix. It suppose there are k experts who rate the importance of the criterion. Where represents the priority scale of criterion compared to criterion .

$$A = \begin{bmatrix} \tilde{a}_{11} & \tilde{a}_{12} & \tilde{a}_{13} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & \tilde{a}_{22} & \tilde{a}_{23} & \cdots & \tilde{a}_{2n} \\ \tilde{a}_{31} & \tilde{a}_{32} & \tilde{a}_{33} & \cdots & \tilde{a}_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \tilde{a}_{n3} & \cdots & \tilde{a}_{nn} \end{bmatrix} \quad (1)$$

Next, construct a fuzzy matrix based on the fuzzy members and the fuzzy inverse ratio.

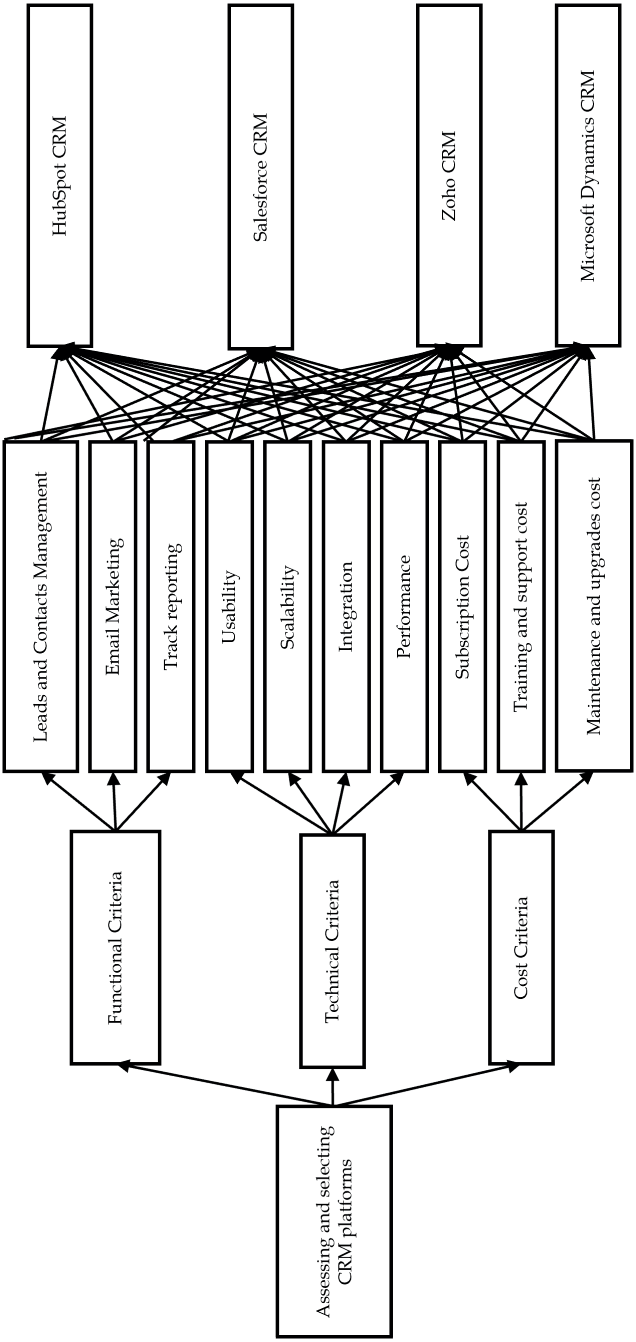

Figure 2. **Hierarchical structure diagram**

Source: own study

In Equation (1), if the weights of matrix A are elements, then in the comparison matrix, each pair will be the inverse of the elements symmetrical about the main diagonal of the matrix.

$$A = \begin{bmatrix} 1 & \tilde{a}_{12} & \tilde{a}_{13} & \cdots & \tilde{a}_{1n} \\ 1/\tilde{a}_{12} & 1 & \tilde{a}_{23} & \cdots & \tilde{a}_{2n} \\ 1/\tilde{a}_{13} & 1/\tilde{a}_{23} & 1 & \cdots & \tilde{a}_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 1/\tilde{a}_{1n} & 1/\tilde{a}_{2n} & 1/\tilde{a}_{3n} & \cdots & 1 \end{bmatrix} \quad (2)$$

Step 3. Aggregate the fuzzy matrices

If there are k experts rating the importance of the criterion, then each decision maker's priority will be averaged as shown by the equation below (Chou et al., 2019)

$$\tilde{a}_{ij} = \frac{\sum_{k=1}^{k} \widetilde{a_{ij}^{k}}}{k} \quad (3)$$

in which:

- $\tilde{a}_{ij}$ is the average score of the criteria.
- k is the number of experts evaluating.

Step 4. Calculate the Consistency Rate (CR) of the Fuzzy matrix. A consistency ratio lower than 0.1 means that the expert assessments are consistent. On the contrary, if it is not true, the decision maker needs to re-do the assessments (Isiklar & Buyukozkan, 2006). The Consistency Ratio is calculated according to the following equation (Aguaron et al., 2003).

$$CR = \frac{CI}{RI} \quad (4)$$

where:

- CR is the Consistency Ratio, CI is the Consistency *Index*, RI is the Randomness Index.

The Consistency Index is calculated according to the following equation:

$$CI = \frac{\gamma_{max} - n}{n-1} \quad (5)$$

where:

- γ_{max} is the largest eigenvalue of the judgment matrix.
- n is the number of criteria.

Step 5. Calculate Fuzzy weights

Apply the geometric mean method to calculate the fuzzy geometric mean value for each criterion (Chou et al., 2019).

$$\tilde{r}_i = (\prod_{j=1}^{n} \tilde{a}_{ij})^{\frac{1}{n}} \tag{6}$$

where $\tilde{r}_i$: Fuzzy geometric mean

The fuzzy weights formula is calculated using the equation below:

$$\widetilde{w}_j = \tilde{r}_j \times (\tilde{r}_1 + \tilde{r}_2 + \tilde{r}_3 + \cdots + \tilde{r}_n)^{-1} \tag{7}$$

where $\widetilde{w}_j$: Fuzzy weights of the j^{th} criterion.

Step 6. Fuzzy weight defuzzification and calculate the normalized weight criteria. Since $\widetilde{W}$ is a fuzzy number, it is necessary to defuzzify it by using the Central Area Method. The defuzzification formula is as follows:

$$\overline{\mathrm{W_J}} = \frac{L_{w_j} + M_{w_j} + U_{w_j}}{3} \tag{8}$$

Next step, normalize the obtained values using the following formula:

$$\mathrm{N_i} = \frac{\overline{\mathrm{W_J}}}{\prod_{i=1}^{n} \overline{\mathrm{W_J}}} \tag{9}$$

in which:

- $\overline{\mathrm{W_J}}$: The Real weights of the j^{th} criterion.
- $\mathrm{N_i}$: Normalized Fuzzy Weight criteria.

Step 7. Determine the global weight of the sub-criteria. The global number is calculated by multiplying the weight of the main criterion by the weight of each of its sub-criteria.

Step 8. Ranking the sub-criteria.

3.2.4. Integration of Fuzzy AHP – TOPSIS

Step 1. The linguistic scale in implementing the alternative i=1, 2, ..., m and the criterion j=1, 2, ..., n. The Fuzzy value scales for alternative evaluation are used.

The decision matrix is presented as follows:

$$P = \begin{bmatrix} x_{11} & x_{12} & x_{13} & \cdots & x_{1n} \\ x_{21} & x_{22} & x_{23} & \cdots & x_{2n} \\ x_{31} & x_{32} & \tilde{a}_{33} & \cdots & x_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \tilde{a}_{m3} & \cdots & x_{mn} \end{bmatrix} \tag{10}$$

Step 2. Standardize decision matrix (). The process of matrix normalization is performed according to the Equation (11) below:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, i = 1, 2, \ldots, m;\ j = 1, 2, \ldots, n \tag{11}$$

Step 3. Calculate the weighted normalized decision matrix (). In the Equation (12), represents the criterion weights obtained from *Section 3.2.3*, from which the formula for compute the decision matrix normalized weights is as follows:

$$\tilde{v}_{ij} = w_j \times r_{ij} \tag{12}$$

Step 4. Calculate the Positive Ideal Solution (PIS) and Negative Ideal Solution (NIS). Based on the weighted normalized decision matrix, the Positive Ideal Solution () and the Negative Ideal Solution () can be determined according to Equations (13), (14) as follows:

$$A^+ = (max\ v_{ij} | j \in J) = (v_1^+, v_2^+, v_3^+, \ldots, v_j^+, \ldots, v_n^+) \tag{13}$$

$$A^- = (min\ v_{ij} | j \in J) = (v_1^-, v_2^-, v_3^-, \ldots, v_j^-, \ldots, v_n^-) \tag{14}$$

Step 5. Determine the distance of each alternative to PIS and NIS. Calculate the distance between the weight normalization matrix and the positive ideal solution and negative ideal solution by using the Euclidean distance formula as follows:

$$d_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2},\ \text{i= 1, 2, …, m} \tag{15}$$

$$d_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)^2},\ \text{i= 1, 2, …, m} \tag{16}$$

Step 6. Compute the closeness compared to the ideal solution (CCi). After computing the values di and di of each alternative, calculate the distance ratio between the selected alternatives and the ideal solution points CCi. The larger this ratio shows the closer the selected option is to the positive ideal solution. The formula of Relative closeness of alternatives is given as below:

$$CCi = \frac{d_i^-}{d_i^- + d_i^+} \tag{17}$$

Step 7. Ranking the alternatives. Based on the CCi index just calculated in the previous step, rank the alternatives. From there, find the best choice among the initially given options.

4. Results

The case of Test Mentor Co., Ltd. was chosen as a case study. The company started using the HubSpot CRM package in early 2023. Research and interview 5 people with in-depth knowledge of CRM and knowledge of related fields such as Marketing. Interview the perspectives and reviews of people who are using the CRM platform at the company or have used it before. The direct interview method is carried out based on a pre-prepared questionnaire. The collected responses will be used as data for the research article. Applying this method helps orient and answer[1] research questions and limit errors during the interview process. After data collection, the Fuzzy AHP-TOPSIS method will be used for analysis. Through this research, the author hopes to help Test Mentor company choose the appropriate CRM platform to enhance the company's Digital Marketing activities. Table 3 provides brief information about the group of experts selected for interview.

Table 3. **A group of experts participated in the case study**

Expert	Gender	Work Experience	Job position
E1	Male	Have more than 10 years of experience in managing the marketing department, clearly understand the business's marketing goals and understand the role of CRM in achieving goals, have solid knowledge of technology and platforms CRM.	Director
E2	Female	6 years of experience implementing and using CRM for businesses. Master CRM features and functions and understand the latest trends in the field.	Senior CRM Consultant
E3	Male	5 years of experience implementing digital marketing campaigns with the ability to apply CRM to digital marketing campaigns and measure effectiveness.	Digital Marketing Specialist
E4	Male	3 years of experience using CRM at work and have used many different CRM platforms, can share practical experiences when using CRM, including the advantages and disadvantages of each platform.	Sales department
E5	Female	4 years of experience analyzing Marketing data, can provide detailed information about customer behavior and the effectiveness of marketing campaigns, helping to choose the right CRM platform for the company's needs.	Data Analyst

Source: own study

4.1. Data analytic result

4.1.1.Fuzzy AHP

Step 1. A hierarchical structure diagram including main criteria and sub-criteria is designed from the above mentioned issues as shown in Figure 3.

Step 2. Based on the interview results about the relationship between the criteria of 5 experts at Test Mentor Co., Ltd, combined with using the list of linguistic variables. Apply the formula in Equation (1), (2) to determine the symmetrical equivalence of linguistic assessments in a pairwise comparison matrix.

Step 3. Use Formula (3) to synthesize the opinions of many decision makers. The table 4 – 6 below presents the results of summarizing opinions from experts.

Table 4. **Comparison matrix aggregating each pair of main criteria (C1-C3)**

	C1			C2			C3		
C1	1.000	1.000	1.000	2.267	2.700	3.200	2.233	2.840	3.450
C2	0.665	0.879	1.100	1.000	1.000	1.000	1.317	1.747	2.200
C3	1.113	1.340	1.583	2.083	2.707	3.350	1.000	1.000	1.000

Source: own study

Table 5. **Comparison matrix aggregating each pair of sub-criteria (C11-C13)**

	C11			C12			C13		
C11	1.000	1.000	1.000	2.673	3.290	3.917	0.890	1.117	1.367
C12	1.498	1.919	2.350	1.000	1.000	1.000	0.517	0.747	1.000
C13	1.450	1.867	2.300	2.267	2.900	3.600	1.000	1.000	1.000

Source: own study

Table 6. **Comparison matrix aggregating each pair of sub-criteria (C21-C24)**

	C21			C22			C23			C24		
C21	1.000	1.000	1.000	1.675	2.095	2.533	1.525	1.962	2.433	0.933	1.373	1.850
C22	1.873	2.290	2.717	1.000	1.000	1.000	0.917	1.367	1.900	2.850	3.457	4.067
C23	2.073	2.690	3.317	0.917	1.367	1.900	1.000	1.000	1.000	2.850	3.457	4.067
C24	1.700	2.333	3.000	2.500	2.924	3.367	2.500	2.924	3.367	1.000	1.000	1.000

Source: own study

Step 4. Apply the consistency formula in Equation (4) to check the consistency of assessments from experts. If this value is lower than 0.1, the judgment matrix is accepted.

Table 7. *Lamda*$_{max}$, CI and CR values of the main criteria (C1-C3)

	E1	E2	E3	E4	E5
	For n = 3				
CI	0.050	0.015	0.009	0.026	0.026
CR	0.087	0.026	0.016	0.045	0.045

Source: own study

Table 8. *Lamda*$_{max}$, CI and CR values of the sub-criteria (C11-C13)

	E1	E2	E3	E4	E5
	For n = 3				
CI	0.031	0.009	0.015	0.054	0.015
CR	0.054	0.016	0.026	0.093	0.025

Source: own study

Table 9. *Lamda*$_{max}$, CI and CR values of the sub-criteria (C21-C24)

	E1	E2	E3	E4	E5
	For n = 4				
CI	0.080	0.061	0.080	0.079	0.063
CR	0.089	0.067	0.089	0.087	0.070

Source: own study

Table 10. *Lamda*$_{max}$, CI and CR values of the sub-criteria (C31-C33)

	E1	E2	E3	E4	E5
	For n = 3				
CI	0.031	0.048	0.026	0.015	0.048
CR	0.054	0.082	0.045	0.025	0.082

Source: own study

Step 5. Use Equations (6), (7) to determine the Fuzzy geometric mean and calculate the Fuzzy weights of the main criteria and sub-criteria. The calculation results are presented in Tables 11 and Tables 12.

Table 11. **The Fuzzy Geometrical geomean and the Fuzzy weights for main criteria (C1-C3)**

Main criteria	Fuzzy geometric means ($\tilde{r}_i$)	Value	Fuzzy weights ($\widetilde{w}_j$)	Value
C1	r_1	(1.717; 1.972; 3.680)	w_1	(0.275; 0.423; 0.921)
C2	r_2	(0.957; 1.153; 0.807)	w_2	(0.153; 0.247; 0.202)
C3	r_3	(1.324; 1.536; 1.768)	w_3	(0.212; 0.330; 0.442)

Source: own study

Table 12. **The Fuzzy Geometrical geomean and the Fuzzy weights for sub-criteria (C11-C33).**

Sub- criteria	Fuzzy geometric means ($\tilde{r}_i$)	Value	Fuzzy weights ($\widetilde{w}_j$)	Value
C11	r_{11}	(1.335; 1.543; 1.784)	w_{11}	(0.251; 0.349; 0.477)
C12	r_{12}	(0.918; 1.127; 0.783)	w_{12}	(0.172; 0.255; 0.209)
C13	r_{13}	(1.487; 1.756; 2.760)	w_{13}	(0.279; 0.397; 0.738)
C21	r_{21}	(1.243; 1.541; 1.838)	w_{21}	(0.144; 0.210; 0.303)
C22	r_{22}	(1.487; 1.814; 2.140)	w_{22}	(0.172; 0.247; 0.353)
C23	r_{23}	(1.526; 1.888; 2.250)	w_{23}	(0.177; 0.257; 0.371)
C24	r_{24}	(1.805; 2.113; 2.415)	w_{24}	(0.209; 0.287; 0.398)
C31	r_{31}	(1.786; 2.133; 4.920)	w_{31}	(0.281; 0.495; 1.365)
C32	r_{32}	(1.027; 1.225; 0.958)	w_{32}	(0.162; 0.284; 0.266)
C33	r_{33}	(0.792; 0.947; 0.475)	w_{33}	(0.125; 0.220; 0.132)

Source: own study

Step 6. Proceed to defuzzify the Fuzzy weights of the main criteria and sub-criteria according to Equation (8), then normalize the weights according to formula (24). The result is given in Table 13 and Table 14.

Table 13. **The results of normalize pairwise comparison matrix for main criteria (C1-C3)**

Main criteria	Defuzzified weights ($\overline{w_j}$)	Value	Normalized weights criteria (N_j)	Value
C1	$\overline{w_1}$	0.539	N_1	0.505
C2	$\overline{w_2}$	0.201	N_2	0.188
C3	$\overline{w_3}$	0.328	N_3	0.307

Source: own study

Table 14. **The results of normalize pairwise comparison matrix for sub-criteria (C11-C33)**

Sub- criteria	Defuzzified weights ($\overline{w_j}$)	Value	Normalized weights criteria (N_j)	Value
C11	$\overline{w_{11}}$	0.359	N_{11}	0.344
C12	$\overline{w_{12}}$	0.212	N_{12}	0.204
C13	$\overline{w_{13}}$	0.471	N_{13}	0.452
C21	$\overline{w_{21}}$	0.219	N_{21}	0.210
C22	$\overline{w_{22}}$	0.257	N_{22}	0.247
C23	$\overline{w_{23}}$	0.268	N_{23}	0.257
C24	$\overline{w_{24}}$	0.298	N_{24}	0.286
C31	$\overline{w_{31}}$	0.714	N_{31}	0.643
C32	$\overline{w_{32}}$	0.237	N_{32}	0.214
C33	$\overline{w_{33}}$	0.159	N_{33}	0.143

Source: own study

Step 7. The global number is calculated by multiplying the weight of the main criterion by the weight of each of its sub-criteria. The global weight results for each criterion are given in Table 15.

Table 15. **Global weights for each criterion**

Main criteria	Main criteria weights	Sub-criteria	Sub-criteria weights	Global weights
C1	0.505	C11	0.344	0.174
		C12	0.204	0.103
		C13	0.452	0.228
C2	0.188	C21	0.210	0.039
		C22	0.247	0.046
		C23	0.257	0.048
		C24	0.286	0.054
C3	0.307	C31	0.643	0.197
		C32	0.214	0.066
		C33	0.143	0.044

Source: own study

Step 8. The global weighted ranking results for each criterion are presented in Table 16.

Table 16. **Ranking results of CRM platform evaluation criteria**

Sub-criteria	Global weights	Ranking results
C11	0.174	3
C12	0.103	4
C13	0.228	1
C21	0.039	10
C22	0.046	8
C23	0.048	7
C24	0.054	6
C31	0.197	2
C32	0.066	5
C33	0.044	9

Source: own study

Based on Table 16 and the weights of 3 main criteria: Functional Criteria (C1), Technical Criteria (C2) and Cost Criteria (C3) with 10 sub-criteria: Track reporting (C13) is the highest criterion with 22,84%, followed by Subscription cost (C31), Leads and contacts management (C11) with 19,74%, 17,39% respectively. In addition, the criteria have low weight such as Usability (C21) with 3,95%, Training & support cost (C33) with only 4,39%. It can be said that the criteria with the largest volume have the highest level of importance.

4.1.2. TOPSIS

Step 1. There are 5 decision makers evaluating CRM platforms by using the language scale. Then, the results compiled from experts will be presented in Table 17.

Table 17. **The results of subjective assessment of decision makers for five levels of linguistic variables (C11-C22)**

	C11			C12			C13			C21			C22		
A1	5.00	7.00	8.60	5.00	7.00	8.80	6.60	8.60	9.80	5.80	7.80	9.40	3.80	5.80	7.60
A2	3.80	5.80	7.60	3.80	5.80	7.80	1.40	3.00	5.00	3.40	5.40	7.40	2.40	4.20	6.20
A3	3.60	5.40	7.20	5.00	7.00	8.60	4.20	6.20	8.00	4.20	6.20	7.80	5.00	7.00	8.40
A4	2.20	3.80	5.80	5.40	7.40	8.80	1.40	3.40	5.40	4.60	6.60	8.20	3.00	5.00	7.00

Source: own study

Step 2. Normalize the decision matrix according to Formula (10). The normalized decision matrix is displayed in Table 18.

Table 18. **Fuzzy normalized decision matrix for each criterion (C11-C22)**

	C11			C12			C13			C21			C22		
A1	0.42	0.43	0.44	0.43	0.44	0.44	0.44	0.45	0.45	0.44	0.44	0.45	0.39	0.42	0.44
A2	0.39	0.42	0.44	0.41	0.43	0.44	0.32	0.38	0.42	0.41	0.43	0.44	0.36	0.40	0.42
A3	0.36	0.39	0.42	0.42	0.43	0.44	0.40	0.42	0.44	0.38	0.41	0.43	0.40	0.42	0.43
A4	0.34	0.38	0.41	0.42	0.43	0.44	0.39	0.44	0.44	0.40	0.42	0.44	0.38	0.42	0.43

Source: own study

Step 3. The fuzzy weight normalized decision matrix is calculated by using Formula (11) and presented in Table 19-20.

Table 19. **Fuzzy weight standardized decision matrix for each criterion (C11-C22)**

	C11	C12	C13	C21	C22
A1	0.08	0.05	0.10	0.02	0.02
A2	0.07	0.04	0.10	0.02	0.02
A3	0.07	0.04	0.10	0.02	0.02
A4	0.07	0.04	0.10	0.02	0.02

Source: own study

Table 20. **Fuzzy weight standardized decision matrix for each criterion (C23-C33)**

	C23	C24	C31	C32	C33
A1	0.05	0.02	0.08	0.03	0.02
A2	0.05	0.02	0.08	0.02	0.02
A3	0.05	0.02	0.09	0.03	0.02
A4	0.05	0.02	0.08	0.03	0.02

Source: own study

Step 4. Calculating the F-PIS and F-NIS and the results shown in the Table 21.

Table 21. **Fuzzy Positive Ideal Solution and Fuzzy Negative Ideal Solution**

	C11	C12	C13	C21	C22	C23	C24	C31	C32	C33
F-PIS	0.075	0.045	0.100	0.018	0.019	0.048	0.024	0.086	0.029	0.019
F-NIS	0.065	0.044	0.098	0.016	0.019	0.048	0.020	0.078	0.025	0.015

Source: own study

Step 5. The distance of each alternative to PIS, NIS is calculated according to Equations (15) and (16) shown as the Table 22.

Table 22. **The distance of each alternative from Fuzzy positive ideal solutions and Fuzzy negative ideal solutions**

Distance	Alternatives			
	A1	A2	A3	A4
d^+	0.004	0.024	0.013	0.028
d^-	0.032	0.013	0.024	0.008

Source: own study

Step 6 -7. Use Equation (17) to calculate the closeness to the ideal solution and rank the options.

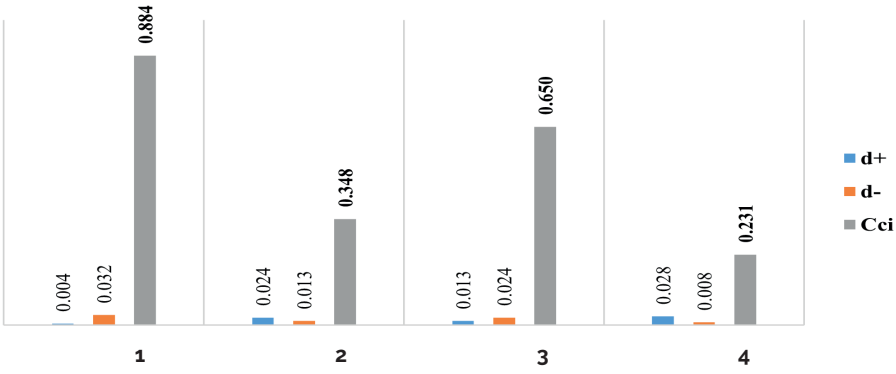

Figure 3. **Separation measure and the closeness index for each alternative**

Source: own study

Results from Table 22 show that the coefficient of closeness to option A1 is the highest. The CRM platform with the highest rating is A1 (HubSpot CRM) with a score of 0.884. Next are the platforms A3 (Zoho CRM), A2 (Salesforce CRM) with scores of

0.650 and 0.348 respectively. The lowest ranking is A4 (Microsoft Dynamics CRM) with a score of 0.231. As the results in Figure 4.1 also show that the closeness coefficient of option 1 is the highest, which proves that A1 is the closest option compared to the positive ideal solution. Therefore, HubSpot is the CRM platform most suitable for businesses to help improve customer service and increase revenue, followed by Zoho CRM and Salesforce CRM platforms respectively. This result helps Test Mentor Co., Ltd choose the most suitable CRM platform in enhancing the effectiveness of Digital Marketing activities. The consistency between Table 23 and Figure 3 reinforces the robustness of the ranking, confirming that A1 dominates the decision space under the applied weighting structure. Importantly, this outcome reflects Test Mentor Co., Ltd.'s strategic emphasis on functional and marketing-oriented capabilities rather than purely technical sophistication. Consequently, HubSpot CRM emerges as the most appropriate platform to support digital marketing effectiveness, customer engagement, and revenue growth, followed by Zoho CRM and Salesforce CRM, whose lower rankings highlight trade-offs between functionality, usability, and strategic fit rather than absolute system capability. The calculated Fuzzy AHP weights are used to explain the strategic rationale behind the final TOPSIS rankings, moving beyond numerical results to interpret managerial meaning. The significantly higher weight assigned to the criteria indicates that marketing automation, campaign management, and customer engagement capabilities are the most critical decision factors, which directly explains why HubSpot CRM achieves the highest overall ranking and aligns with the firm's strategic focus on digital marketing excellence.

Table 23. **The final ranking of alternatives**

	Alternative	cc_i	Final rank
A1	Hubspot CRM	0.884	1
A2	Salesforce CRM	0.348	3
A3	Zoho CRM	0.650	2
A4	Microsoft Dynamics CRM	0.231	4

Source: own study

4.1.3. Sensitivity analysis

Sensitivity analysis is conducted to examine the impact of changing the priority weights of the evaluation and ranking of criteria (Prakash & Barua, 2015). The idea of sensitivity analysis by (Onut & Soner, 2007) is to exchange the weight of each criterion with the weight of another criterion while keeping the remaining weights unchanged. Therefore, 45 cases of changing the weight of 10 sub-criteria will be analyzed, where each change is stated as an alternative. For each alternative, the similarity of the transit centers to the ideal solution is calculated. To confirm the results, 45 experiments were performed as described figure 4 illustrates the graphical representation Sensitive analysis results.

A1 holds the highest position in all cases and A3 is in second place in all cases. Option A2 holds the fourth position in 4 out of 45 cases (Experiments 4,5,6,9), in the remaining case A2 holds the third position. Option A4 holds the fourth position in most cases, A4 only holds the third position in 4 out of 45 cases.

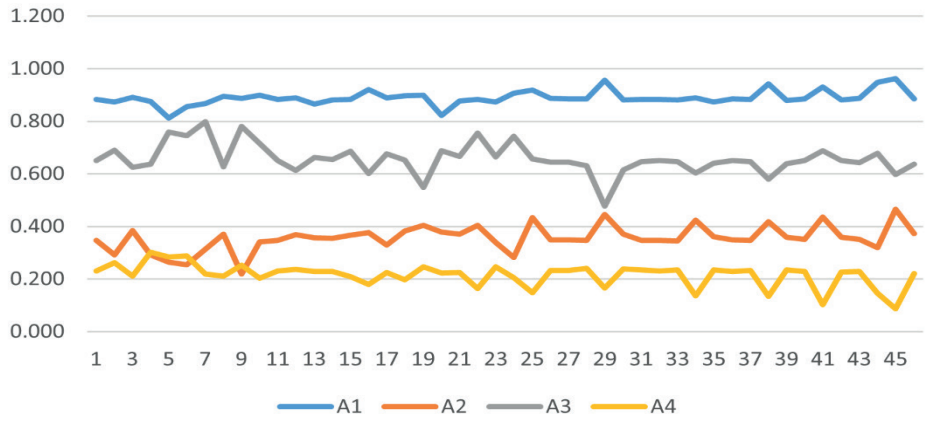

Figure 4. **Sensitivity analysis results**

Source: own study

The sensitivity analysis depicted in Figure 4 demonstrates the robustness of the ranking outcomes under varying weight distributions across 45 scenarios. Alternative A1 (HubSpot CRM) consistently maintains the highest closeness coefficient, ranging between approximately 0.85 and 0.95, indicating strong stability and dominance

irrespective of criterion weight adjustments. A3 (Zoho CRM) exhibits moderate stability, with values fluctuating between 0.55 and 0.70, confirming its position as the second-best alternative across all cases. In contrast, A2 (Salesforce CRM) and A4 (Microsoft Dynamics CRM) display lower and more volatile coefficients, with A2 oscillating around 0.30–0.45 and A4 remaining below 0.25 in most scenarios, underscoring their limited competitiveness. These findings validate the reliability of the Fuzzy AHP–TOPSIS model and reinforce the conclusion that HubSpot CRM is the most resilient and strategically suitable choice for enhancing digital marketing effectiveness.

5. Conclusions

This study aims to integrate the Fuzzy AHP method and TOPSIS to make a decision framework to effectively select a CRM platform. This method supports decision making for multi-criteria and multi-option problems, especially suitable for choosing complex software systems such as CRM. In the current era of developed digital technology, implementing a customer relationship management system is no longer strange to businesses. A case study of Test Mentor Co., Ltd is a practical illustration of how to use the proposed model and shows its effectiveness in choosing the right CRM platform for company. With the transition from the traditional economy and growing competition in new dimensions, choosing a good CRM platform will help businesses enhance the effectiveness of marketing activities and increase competitive advantage in the new economic environment. The Fuzzy AHP model combined with TOPSIS can be widely applied in many fields such as logistics, IT, healthcare, banking... helping decision making simpler and more convincing. This work contributes to solving the difficulties in choosing a CRM platform for businesses by providing a powerful tool to rank CRM platforms and analyze the relationship between criteria.

Firstly, the research results contribute to helping Test Mentor Co., Ltd improve the effectiveness of Digital Marketing activities through choosing the most suitable CRM platform. However, this study only applies the proposed model to a typical case. The author suggests that future studies should apply this proposed model and expand the survey sample to a larger sample to achieve more general results. The interview can be conducted with experts outside the company and experts with many years of CRM experience. Secondly, in this article, the evaluation and selection of a CRM platform is based on the Fuzzy AHP and TOPSIS methods. To achieve better results, further studies can deploy other methods and compare the results of this study with these methods. Thirdly, besides the contributions of this essay, this research cannot avoid some limitations. The author develops a set of criteria is

based on reference documents, so it is not possible to evaluate the appropriateness of the set of criteria used. This will be the premise for further research to develop appropriate evaluation criteria to ensure accuracy and objectivity in the evaluation process. Finally, clarifying the company's requirements and expectations when choosing a CRM platform to deploy is also necessary and important to choose the appropriate system.

This study acknowledges a limitation in generalizability due to its reliance on a single-company case study and a five-expert panel. This narrow scope was an intentional methodological choice to ensure high internal validity and domain-specific depth, which is essential for consensus-based techniques such as Fuzzy AHP. Future research should expand the sample to include multiple organizations and a broader expert panel to enhance external validity and allow comparative analysis across diverse contexts.

Acknowledgement

This research is supported by Ho Chi Minh city University of Technology and Engineering.

Declaration of Generative AI and AI-assisted technologies in the writing process

While preparing this work, the author does not use any tool/service.

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