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Evaluation of Digital Marketing Technologies with Mcdm Methods

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Abstract

With the increase of the digital technologies and their application areas, marketing sector is changing day by day. This change affects the consumer behaviors, business models, marketing strategies and competition capabilities. With the development of digital technologies, large and medium-sized enterprises become more advantageous in terms of sales compared to their competitors in the market. Through the use of digital technologies in marketing, companies can establish a systematic relationship with their customers by increasing the power of public relations. However, the evaluation of digital marketing technology is very complex since it has many conflicting objectives and many different criteria. Multi criteria decision-making (MCDM) is a powerful tool widely used for solving this type of problems. Therefore, in this study, we aim to propose an evaluation framework for digital marketing technologies with MCDM methods. After determining the evaluation criteria and alternatives, two MCDM methods are used in the evaluation procedure. Analytic Hierarchy Process (AHP) is used for determining the weights of criteria and COPRAS (Complex Proportional Assessment) is applied for ranking digital marketing technologies. Finally, an application is provided to demonstrate the potential use of the proposed methodology.

Keywords: AHP, COPRAS, Digital technology, Marketing, MCDM.

1. Introduction

With the increase of the digital technologies and their application areas, marketing sector is changing day by day. This change affects the consumer behaviors, business models, marketing strategies and competition capabilities. In order to keep up with the changes, one of the prominent concepts in the marketing sector is digitalization. Nowadays, creating a digital brand image and increasing the brand value have a great importance. Companies that take advantage of the opportunities provided by the digital environment, reach their customers by using digital channels, manage their sales and orders and customer relations after sales easily (Hanson & Kalyanam, 2000; Mort & Drennan, 2002; Siau & Yang, 2017).

With the development of digital technologies, large and medium-sized enterprises become more advantageous in terms of sales compared to their competitors in the market. Through the use of digital technologies in marketing, companies can establish a systematic relationship with their customers by increasing the power of public relations best (Büchner & Mulvenna, 1998; Cui et al., 2006; Nguyen & Simkin, 2017). However, the evaluation of digital marketing technology is very complex since it has many conflicting objectives and many different criteria. Multi criteria decision-making (MCDM) is a powerful tool widely used for solving this type of problems.

The MCDM is one of problems the most popular treaties by the researchers in the literature. MCDM refers to find the best opinion from all of the feasible alternatives. One of the most outstanding MCDM approaches is the Analytic Hierarchy Process (AHP) which has its roots on obtaining the relative weights among the factors and the total values of each alternative based on these weights (Saaty, 2005). Complex Proportional Assessment (COPRAS) is applied to rank and evaluate alternatives in terms of importance and benefit ratings. Compared with other MCDM methods such as TOPSIS, it is a very simple method to use less calculation time. The method allows evaluation of both qualitative and quantitative criteria.

The aim of the study is to propose an evaluation framework for digital marketing technologies with MCDM methods. After determining the evaluation criteria and alternatives, two MCDM methods are used in the evaluation procedure. AHP is used for determining the weights of criteria and COPRAS is applied for ranking digital marketing technologies.

The structure of the paper is as follows: The related studies about the digital marketing technology are summarized in next section. Section 3 provides the research methodology and proposed model. Section 4 present an application of the methodology. Finally, Section 5 provided concluding remarks and future perspectives.

2. Literature Review of Digital Marketing Technology

In the literature, there are many studies on digital marketing which is a popular subject of recent times. These studies are generally about the general marketing concept. There are not much studies involved in the use of digital marketing with innovative and developing technologies. These studies are given in Tab. 1.

Table 1. Literature review of digital marketing technology

Author (Year)	Aim of the Study	Application Area
Langan et al. (2019)	To construct the state of art digital marketing in academia	Digital marketing courses
Hardy et al. (2018)	To evaluate the impact of marketing and education on knowledge	Carrier screening
Teixeira et al. (2018)	To find the most relevant and important factors in the adoption of digital marketing in startups	Start ups
Ghotbifar et al. (2017)	Identify and assess factors affecting skill gap in digital marketing	Communication industry
Kosasi & Yuliani (2017)	To identify and analyze to what extent digital marketing strategy can improve organizational agility of MSMEs	Micro, small, and medium enterprises (MSMEs)
Tardan et al. (2017)	To formulate a digital marketing strategy for mobile commerce	Mobile commerce based collaborative consumption organizations
Togawa et al. (2017)	To investigate the affective digital marketing	Customer behaviors
Zerr et al. (2017)	To develop a classification of context dimensions with respect to their relevance	Context sensitive digital marketing
Markic et al. (2016)	To integrate information technology and data mining tools, for visualizing the attitudes and opinions on the social networks	Sentiment analysis of social networks
Rao et al. (2016)	To present the technical components of digital marketing and various challenges and opportunities	Digital marketing ecosystem optimization
Hajjar & Syed (2015)	To extract sentiment and emotion from tweets for digital marketing purposes	Sentiment analysis and emotion analysis on Twitter

Taiminen & Karjaluoto (2015)	To provide insights into the utilization and goals of digital marketing	Small, and medium enterprises (SMEs)
Wirawan & Oktivera (2015)	To analyze the implementation of the digital marketing strategies of online taxi motorbike	Online taxi

We searched the terms "digital marketing" and "technology" in Web of Science and Google Scholar. Several studies concerning digital marketing and technology are summarized in Tab. 1. From the Tab. 1, it is possible to say that studies are focused on analysis of digital marketing on customer behaviors.

MCDM tools are implemented in "digital marketing" field in some of the studies. For instance, Watrobski et al. (2016) evaluated marketing management by using TOPSIS method which known as an MCDM technique. Kaltenrieder et al. (2016) used Fuzzy ANP tool for digital marketing optimization. Khatwani and Das (2016) used an integrated MCDM system to measure the role that demographic parameters on information channels.

In the literature, there is no study combining the digital marketing and technology together based on the MCDM techniques. In this study, we aim to fill this literature gap by proposing a digital marketing technology evaluation combined MCDM analytic techniques.

3. The Proposed Model and Methodology

The proposed methodology in this study consists of three basic steps:

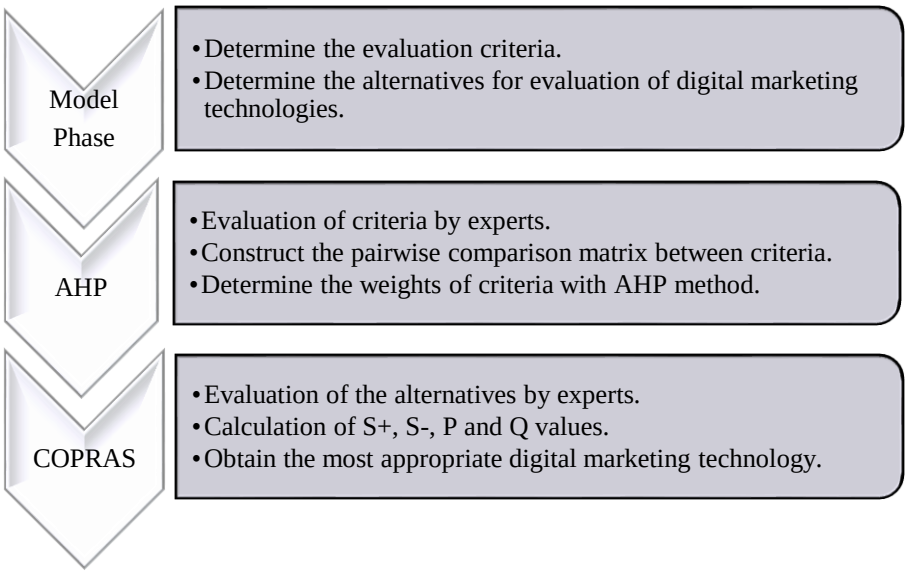
Step 1. Determination of criteria and alternatives for evaluation of digital marketing technologies.

Step 2. Determination of the evaluation criteria's importance degree in the proposed model by AHP method.

Step 3. Evaluation of digital marketing technologies by COPRAS method according to the criteria.

The flowchart of the methodology illustrated in Fig. 1.

Figure 1: The flowchart of the methodology

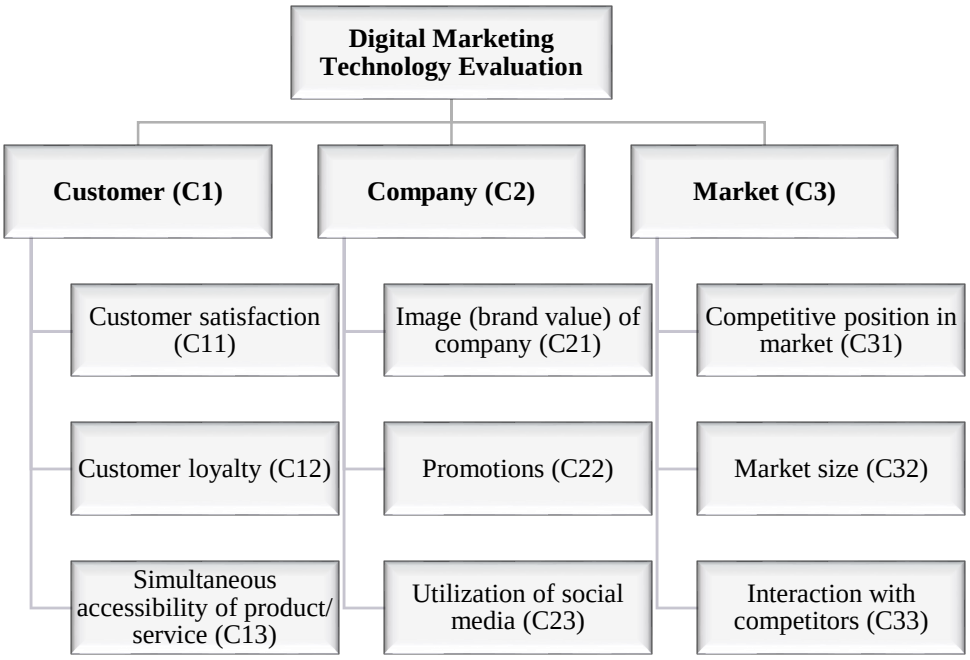


3.1 The Proposed Evaluation Model

As a result of the literature review and expert opinions, the digital marketing technology evaluation model is shown as in Fig. 2.

In this model, there are three main criteria: customer, company and market. There are three sub-criteria of this each main criterion.

Figure 2: The proposed evaluation model



Nowadays, digital marketing needs to be supported by digital technologies to be more effective. The technologies used in digital marketing are as follows:

- *Artificial Intelligence:* The chatbots that is usually right below in web site, automatic assistants to guide you when setting up a program, and applications such as Siri and Alexa on smartphones are artificial intelligence products. This chatbot remembers your preferences and advise you accordingly and try to meet your needs. For companies, artificial intelligence-supported talkative interfaces are very important. They want high-quality communication with customers and think that digitalization is necessary to make it the best (Büchner & Mulvenna, 1998; Wierenga, 2010; Martínez-López & Casillas, 2013, Membrillo, 2019).
- *Big Data:* Big data concept is digitalization of data and data gathered in different dimensions to understand human behavior, to make predictions etc. Thanks to the big data, the companies provide smart management with the help of the data. In addition, marketers can communicate the customers according to their feelings, locations and tastes thanks to location in social media networks, lifestyle skills (Burns et al., 2000, Tirunillai & Tellis, 2014; Verhoef, Kooge & Walk,2016).
- *Augmented/Virtual Reality:* Augmented reality is a technology that allows the real-world physical environment to live in real-time with sensory inputs generated through the computer. Companies are influencing customers with augmented/virtual reality by providing them different experiences that are not normally possible. Companies can use virtual reality applications to show the production phase of their products to consumers. Consumers who learn the story of the products they buy with an exciting experience will increase their interest in the brand (Burns et al., 2000; Zhang et al., 2000; Barnes, 2016).
- *Machine Learning:* Nowadays, marketers need more information than gender, race, age, job status information to fully understand their customers for creating user segments such as user profiles, social posts, interests, and identifying the right communication strategy for each campaigns. These data may seem too complex and complicated but with machine learning, marketers can access all this customer information to make meaningful connections (Cui et al., 2006; Siau & Yang, 2017).
- *Internet of Thing:* The Internet of Things causes the marketing processes to move faster and provides companies with real-time marketing. Thanks to the changing marketing strategies with the Internet of things, the time between marketing and sales is reduced and the sales process becomes much faster and easier. The objects connected to the Internet allow the simultaneous and general needs of the customer to learn from the daily life (Burns et al., 2000; Jara et al., 2014; Nguyen & Simkin, 2017).

3.2 AHP Method for Calculation of Criteria Weights

AHP is developed by Saaty (1980), probably the best-known and most widely used model in decision making. It is a powerful decision making methodology in order to determine the priorities among different criteria. AHP method includes the following steps:

Step 1. Define the problem and determine the kind of knowledge sought.

Step 2. Structure the decision hierarchy from the top with the goal of the decision, then the objectives from a broad perspective, through the intermediate levels to the lowest level.

Step 3. Construct a set of pairwise comparison matrices. Each element in an upper level is used to compare the elements in the level immediately below with respect to it.

The matrix A is a $m \times m$ real matrix, where m is the number of evaluation criteria considered. Each entry a_{jk} of the matrix A represents the importance of the j^{th} criterion relative to the k^{th} criterion. If $a_{jk} > 1$, then the j^{th} criterion is more important than the k^{th} criterion, while if $a_{jk} < 1$, then the j^{th} criterion is less important than the k^{th} criterion. If two criteria have the same importance, then the entry a_{jk} is 1. The entries a_{jk} and a_{kj} satisfy the following constraint:

$$a_{jk}.a_{kj} = 1 \quad (1)$$

Obviously, $a_{jj} = 1$for all j.

Table 2. Evaluation scale for AHP (Saaty, 2005)

Value of ajk	Interpretation
1	j and k are equally important
3	j is slightly more important than k
5	j is more important than k
7	j is strongly more important than k
9	j is absolutely more important than k

To make comparisons, a scale that indicates how many times more important one element is over another element with respect to the criterion is used (Tab. 2).

Once the matrix A is built, it is possible to derive from A the normalized pairwise comparison matrix A_{norm} by making equal to 1 the sum of the entries on each column, i.e. each entry a jk of the matrix A_{norm} is computed as (Saaty, 2008):

$$\bar{a}_{jk} = \frac{a_{jk}}{\sum_{i=1}^{m} a_{jk}}. \quad (2)$$

Finally, the criteria weight vector *w* is built by averaging he entries on each row of A_{norm} as:

$$w_j = \frac{\sum_{l=1}^{m} \bar{a}_{jl}}{m}. \quad (3)$$

Step 4. Use the priorities obtained from the comparisons to weigh the priorities in the level immediately below. Do this for every element. Then for each element in the level below add its weighed values and obtain its overall or global priority. Continue this process of weighing and adding until the final priorities of the alternatives in the bottom most level is obtained (Işıklar and Büyüközkan, 2007).

Step 5. This method also calculates a consistency ratio (CR) to reflect the consistency of decision maker's judgments during the evaluation phase. The inconsistency index in both the decision matrix and in pairwise comparison matrices could be calculated with the equation (Işıklar & Büyüközkan, 2007):

$$CI = \frac{\lambda_{max} - N}{N-1}. \quad (4)$$

3.3 COPRAS Method for Evaluation of Digital Marketing Technologies

The COPRAS is a method of evaluating alternatives by making step-by-step sequencing of alternatives in terms of importance and utility ratings. It is one of the notable MCDM methods, which select the most appropriate alternative by determining (Zavadskas et al., 1994).

The procedure of the COPRAS method includes the following steps:

Step 1. The decision matrix is formed by using scale in Tab. 2.

Step 2. Normalize the decision matrix using the following formula:

$$\boldsymbol{x_{ij}^{*}} = \frac{\boldsymbol{x_{ij}}}{\sum_{i=1}^{m} \boldsymbol{x_{ij}}} \quad \text{for (j= 1,2, …,n)} \quad (5)$$

Step 3. Determine the weighted normalized decision matrix with Eq. 6.

$$d_{ij} = x_{ij}^{*}.w_j \quad (6)$$

Step 4. The sums S_i^- and S_i^+ of weighted standardized values are calculated using the following equations for both beneficial and non-beneficial criteria separately:

$$S_{i+} = \sum_{j=1}^{k} d_{ij} \quad (7)$$

$$S_{i-} = \sum_{j=k+1}^{n} d_{ij} \quad (8)$$

Step 5. The Q_i values are relative importance values for each alternative and are calculated using the Eq. 9. The result of the calculations is determined as the best alternative with the highest relative importance value.

$$Q_i = S_{i+} + \frac{\sum_{i=1}^{m} S_{i-}}{S_{i-} * \sum_{i=1}^{m} \frac{1}{S_{i-}}} \quad (9)$$

Step 6. The highest relative priority (Q_{max}) value is found.

Step 7. Calculate the performance index (Pi) of each alternative with this equation:

$$P_i = \left[\frac{Q_i}{Q_{max}}\right] \times 100\% \quad (10)$$

4. Application

There is a company, which wants to invest the most appropriate digital marketing technology to increase competitiveness. There are five possible alternatives to evaluate the digital marketing technologies: A1 is “Artificial Intelligence”. A2 is “Big Data”. A3 is “Augmented/ Virtual Reality”, A4 is “Machine Learning” and A5 is “Internet of Things”.

The company must take a decision according to the following nine criteria such as customer satisfaction (C11), customer loyalty (C12), simultaneous accessibility of product/ service (C13), image (brand value) of company (C21), promotions (C22), utilization of social media (C23), competitive position in market (C31), market size (C32) and interaction with competitors (C33). The five possible alternatives Ai (i = 1, 2, 3, 4, 5) are to be evaluated using the AHP and COPRAS methods.

4.1 Calculation of Criteria Weights with AHP Method

Step 1. Evaluation criteria and hierarchical structures are given in the previous section.

Step 2. The pairwise comparison decision matrices for main criteria and sub-criteria are constructed by experts by using Saaty's nine-point scale in Tab. 2. The pairwise comparison matrix for main criteria is shown as Tab. 3.

Table 3. Pairwise comparison matrix for main criteria

	C1	**C2**	**C3**
C1	1.000	3.000	5.000
C2	0.333	1.000	3.000
C3	0.200	0.333	1.000

The expert uses the fundamental 1–9 scale defined by Saaty to assess the priority score. In this context, the assessment of 1 indicates equally important, 3 slightly more important, 5 more important, 7 strongly more important and 9 indicates absolutely more important (Tab. 2).

Step 3. The matrix is normalized by using Eq. 2.

Step 4. CR is calculated for all matrices.

These steps are also applied for sub-criteria. Finally, the criteria weights are calculated as in Tab. 4.

Table 4. Final criteria weights

Main Criteria	**Global Weights**	**Sub-criteria**	**Final Criteria Weights**
C1	0.633	C11	0.304
		C12	0.257
		C13	0.073
C2	0.260	C21	0.165
		C22	0.028
		C23	0.068
C3	0.106	C31	0.071
		C32	0.009
		C33	0.026

At the end of the AHP method, the most important criterion is found to be the "Customer satisfaction (C11)". The second important is "Customer loyalty (C12)" and the third ranked factor is "Image (brand value) of company (C21)".

4.2 Evaluation of Digital Marketing Technologies with COPRAS Method

By using the criteria weights found with AHP, digital marketing technologies will be evaluated with the COPRAS method.

Step 1. The decision matrix is established and this matrix is normalized by using Eq. 5.

Step 2. The weighted normalized decision matrix of the alternatives is calculated by multiplying the normalized decision matrix and the weights. The weighted normalized matrix is as shown in Tab. 5.

Table 5. The weighted normalized decision matrix

	C11	C12	C13	C21	C22	C23	C31	C32	C33
A1	0.184	0.238	0.021	0.094	0.002	0.018	0.021	0.004	0.019
A2	0.026	0.048	0.007	0.056	0.016	0.041	0.035	0.006	0.003
A3	0.184	0.048	0.035	0.056	0.007	0.029	0.049	0.003	0.013
A4	0.079	0.048	0.035	0.056	0.007	0.029	0.021	0.003	0.008
A5	0.132	0.048	0.049	0.094	0.020	0.029	0.021	0.004	0.008

Step 3. The values of Si+, Si-, Qi and Pi are calculated by using Eq. 7-10. Tab. 6 shows the results.

Tab 6. The ranking of the alternatives

	Si+	Si-	Qi	Pi	Rank
A1	0.598	0.004	0.601	100	1
A2	0.232	0.006	0.235	39.08	5
A3	0.422	0.003	0.428	71.21	2
A4	0.283	0.003	0.289	48.08	4
A5	0.401	0.004	0.405	67.32	3

Ultimately, "Artificial Intelligence (A1)" has become the most appropriate digital marketing technology among five alternatives with the final performance value of 100; "Augmented/Virtual Reality (A3)", "Internet of Things (A5)", "Machine Learning (A4)" and "Big Data (A2)" have positioned at the second, third, fourth and fifth ranks with 71.21, 67.32, 48.08 and 39.08 as the final performance values, respectively.

5. Conclusion

The speed of change and renewal of the technology are progressing more and more rapidly every day. As a result of the increase in the rate of change of technology, changes in the marketing sector have occurred. Through the use of digital technologies in marketing, companies can establish a systematic relationship with their customers by increasing the power of public relations. However, the evaluation of digital marketing technology is very complex since it has many conflicting objectives and many different criteria. In this context, the aim of the study to propose an evaluation framework for digital marketing technologies with MCDM methods.

In this study, the basic concepts of the digital marketing technology are reviewed. After determining the evaluation criteria and alternatives, two MCDM methods are used in the evaluation procedure. AHP is used for determining the weights of criteria and COPRAS is applied for ranking digital marketing technologies. There are five alternatives for evaluation of digital marketing technology and the most appropriate alternative is "Artificial Intelligence (A1)". Especially, chatbots in artificial intelligence is very important for digital marketing. They remember customers' preferences and advise them accordingly and try to meet customers' needs.

The subject the digital marketing technology evaluation can be advanced in future studies by increasing the number of criteria and alternatives or using different decision making methods. Another perspective can be to consider uncertainty using fuzzy approach.

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