A Fuzzy AHP Approach for Assessing Value Proposition in eCommerce Websites in SMEs in Abu Dhabi

Ahmad Ghandour

Abstract—Small and Medium Enterprises (SMEs) continue to struggle to measure the success of their website. This results in ineffective eCommerce activities and the consequent disappointment in recognisable benefits. Whilst a web marketing mix is a reference that can be used to measure the performance of a website, it does not consolidate the website offerings and it introduces fuzziness and vagueness when assessing the website. In this paper, because assessing a website can be seen as a multi-criteria decision making (MCDM), a fuzzy analytic hierarchy process (FAHP) approach is used to evaluating eCommerce websites, which can tolerate vagueness and uncertainty of judgment. A case study is presented to demonstrate this approach

Keywords— Website, eCommerce, Performance, web marketing mix, FAHP

I. Introduction

ABU DHABI businesses are increasingly investing in online trading. In particular, Small and Medium Enterprises (SMEs) are motivated to invest in this way of doing business and have a website for eCommerce. Indeed, eCommerce website have proliferated as managers are advised that trading online is an essential part of today's business practice and used by businesses across all sectors. Despite the increasing attempts to trade online and the subsequent investments, owners still struggle to meet customers' expectations and engage online customers. This may be a self-reinforcing cycle in that many owners have little knowledge of how to create a web-unique proposition appealing to their target market(s). Although creating an online value proposition is not a new practice, many SMEs are still struggling to create a succinct one. A succinct online value proposition identifies the reason why customers will click on, return, register or buy from the website and feel motivated to share their experience.

If Whilst the literature provides a useful foundation for creating a framework that assists organisations in creating a value proposition for their eCommerce websites, such a framework does not consolidate the website offerings and it introduces fuzziness and vagueness when assessing the website. With this gap in mind, this study presents a fuzzy analytic hierarchy process (FAHP) not only to tolerate vagueness or ambiguity but also to weight evaluation indexes of the website value proposition as assessing a website is seen as a multi-criteria decision making (MCDM) problem.

The rest of the paper is organised as follows: section 2 present the web unique selling proposition for the online space. Section 3 goes over the fuzzy hierarchy analytic process. In Section 4, an empirical example to apply FAHP is carried out. Conclusion remarks are made in the last section.

II. Creating a web unique selling proposition for the online space

Despite their successful physical presence, businesses are investing in setting up websites to sell their good/services with the possibility of abandoning the physical realm, as trading online is becoming more popular. Creating a website for such a purpose requires businesses not only to reflect their strategic initiatives but also to create value for their customers [1-4]. Such value should result in a competitive advantage that is difficult to imitate and ultimately dependent on customer appeal.

Value can therefore be created by assigning a mix of requirements and suggestions identified from the existing studies that have emerged from different theoretical backgrounds and have been informed by somewhat dissimilar goals, and synthesised into a framework that can be used as the basis for website evaluation effort in the context of SMEs [4-6].

The outcome is a website that is differentiated from competitors' websites, able to create awareness, generate traffic, and drive sales. To do so, [7] integrated all requirements and suggestion by synthesising the outcomes of various studies related to the same topic. The integration process yielded a framework that requires careful consideration of four elements and establishes a method for ensuring a unique proposition (website Ecellence); Table I provides an illustration.

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TABLE I
E-COMMERCE WEBSITE EXCELLENCE CHECKLIST

Goal Setting	What are the goals of your business strategy What are the objective of your website What online activities are you undertaking to achieve goals and objectives How regularly do you review your online activities
Service	What functionalities are included in your website? How much do you spent keeping the website up-to-date Are you attracting the right customers to your website Do you allow your customer to transact online How do you deliver and exchange information with customers
Marketing	Do you have a marketing plan What marketing activities are you undertaking for your website? What do you do to make your website more search engine friendly How high does your website currently rank on search engine Are you currently undertaking any search engine marketing Are your SEM activities generating the results you want Are you using social media networks What benefits are gaining from Social media How often do maintain your website Is your website up-to-date
Security	Have you identified internet security threats that most apply to your online business What security precaution have you taken to protect your website?

III. THE FUZZY ANALYTIC HIERARCHY PROCESS (FAHP)

A. *The Analytic Hierarchy Process (AHP)*

The analytic hierarchy process (AHP) was first introduced by Saaty in 1971 to solve the scarce resources allocation and planning needs for the military [8]. Since its introduction, the AHP has become one of the most widely used multiple-criteria decision-making (MCDM) methods, and has been used to solve unstructured problems in different areas of human needs and interests, such as political, economic, social and management sciences. However, AHP has shortcomings and does not take into account the uncertainty associated with the mapping of human judgement to a number [9]. As demonstrated by [10-15], the procedures of the AHP involve six essential steps.

B. *Fuzzy set theory*

Zadeh in 1965 introduced fuzzy set theory to solve problems involving the absence of sharply defined criteria [16]. If uncertainty (fuzziness) of human decision-making is not taken into account, the results can be misleading. A commonality among terms of expression, such as "very likely", "probably so", "not very clear", "rather dangerous" that are often heard in daily life, is that they all contain some degree of uncertainty [17] and [18]. Fuzzy theory thus is used to solve such kind of problems, and it has been applied in a variety of fields in the last four decades. Theory of fuzzy sets has evolved in various directions, and two distinct directions are: treating fuzzy sets as precisely defined mathematical objects subject to the rules of classical logic, and the linguistic approach. The underlying logic of linguistic approach is that the truth-values are fuzzy sets and the rules of inference are approximate rather than exact.

A triangular fuzzy number, a special case of a trapezoidal fuzzy number, is very popular in fuzzy applications. As shown in Fig. 1, the triangular fuzzy number $\widetilde{M}$ is represented by (a, b, c), and the membership function is defined as

$$\mu_{\widetilde{M}}(x) = \begin{cases} \frac{x-a}{b-a}, & a \leqslant x \leqslant b \\ \frac{c-x}{c-b}, & b \leqslant x \leqslant c \\ 0, & \text{otherwise} \end{cases} \tag{1}$$

with $-\infty < a \leqslant b \leqslant c < \infty$.

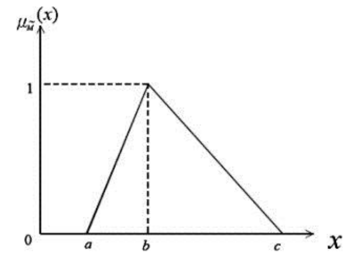

Fig. 1 Membership function of a triangular fuzzy number $\widetilde{M} = (a, b, c)$.

The strongest grade of membership is parameter b, that is, $fM(b) = 1$, while a and c are the lower and upper bounds.

An important concept of fuzzy sets is the α -cut. For a fuzzy number $\widetilde{M}$ and any number $\alpha \in [0, 1]$, the α-cut, $C\alpha$, is the crisp set [19]:

$$C_{\alpha} = \{ x \mid C(x) \geqslant \alpha \} \tag{2}$$

The α - cut of a fuzzy number $\widetilde{M}$ is the crisp set $\widetilde{M}^{\alpha}$ that contains all the elements of the universal set U whose membership grades in $\widetilde{M}$ are greater than or equal to the specified value of α, as shown in Fig. 2.

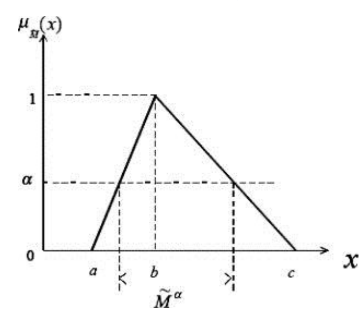

Fig. 2 α -cut of a triangular fuzzy number $\widetilde{M}$.

By defining the interval of confidence at level α, the triangular fuzzy number can be characterized as [10, 20, 21]:

$$\widetilde{M}^{\alpha} = [a^{\alpha}, c^{\alpha}] = [(b-a)\alpha + a, -(c-b)\alpha + c], \quad \forall \alpha \in [0, 1] \tag{3}$$

The distance between two triangular fuzzy numbers can be defined by the vertex method [22].

Let $\widetilde{M}_1 = (a_1, b_1, c_1)$ and $\widetilde{M}_2 = (a_2, b_2, c_2)$ be two triangular fuzzy numbers, the distance between them is

$$d(\widetilde{M}_1, \widetilde{M}_2) = \sqrt{\frac{1}{3}[(a_1 - a_2)^2 + (b_1 - b_2)^2 + (c_1 - c_2)^2]} \quad (4)$$

The main operational laws for two triangular fuzzy numbers $\widetilde{M}_1 = (a_1, b_1, c_1)$ and $\widetilde{M}_2 = (a_2, b_2, c_2)$ are as follows [36]:

$$\widetilde{M}_1 \oplus \widetilde{M}_2 = (a1+a2, b1+b2, c1+c2) \quad (5)$$

$$\widetilde{M}_1 \otimes \widetilde{M}_2 = (a_1a_2, b_1b_2, c_1c_2). \quad (6)$$

$$\lambda \widetilde{M}_1 = (\lambda a_1, \lambda b_1, \lambda c_1),\ \lambda > 0,\ \lambda \in R \quad (7)$$

$$\widetilde{M}_1^{-1} = ((1/a_1, 1/b_1, 1/c_1) \text{ for } ai > 0,\ bi > 0,\ ci > 0. \quad (8)$$

Many methods have been suggested to rank fuzzy numbers, such as intuition ranking method, fuzzy mean and spread, uniform distribution, proportional distribution and $\alpha-$cut method [34, 37]. Centroid ranking method is also often used to rank fuzzy numbers [38]. Each method has its own advantages and disadvantages [40].

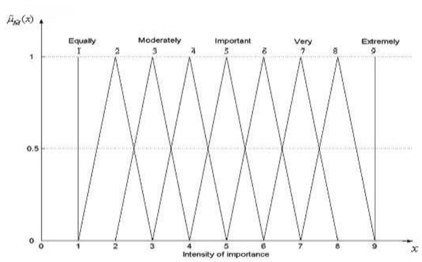

Fig. 3 Fuzzy membership function of linguistic value

A good decision-making model needs to tolerate vagueness or ambiguity because fuzziness and vagueness are common characteristics in many decision-making problems [23]. Since decision makers often provide uncertain answers rather than precise values, the transformation of qualitative preferences to point estimates may not be sensible. Conventional AHP that requires the selection of arbitrary values in pairwise comparison may not be sufficient, and uncertainty should be considered in some or all pairwise comparison values [23]. Since the fuzzy linguistic approach can take the optimism/pessimism rating attitude of decision makers into account, linguistic values, whose membership functions are usually characterized by triangular fuzzy numbers, are recommended to assess preference ratings instead of conventional numerical equivalence method [24]. As a result, the fuzzy AHP should be more appropriate and effective than conventional AHP in real practice where an uncertain pairwise comparison environment exists.

Therefore, in this paper, triangular fuzzy numbers ,1~ ~ 9~ , are used to improve the conventional nine-point scaling scheme in order to capture the vagueness. The corresponding linguistic variables and the image of its membership function are shown in Table II and Fig. 3 respectively.

TABLE II
MEMBERSHIP FUNCTION OF THE LINGUISTICS SCALE

Fuzzy number	Linguistic scales	TFN (ãij)	Reciprocal of a TFN (ãij)
9˜	Absolutely important	(7, 9, 9)	(1/9, 1/9, 1/7)
7˜	Very strongly important	(5, 7, 9)	(1/9, 1/7, 1/5)
5˜	Essentially important	(3, 5, 7)	(1/7, 1/5, 1/3)
3˜	Weakly important	(1, 3, 5)	(1/5, 1/3, 1)
1˜	Equally important	(1, 1, 3)	(1/3, 1, 1)
2˜,4˜,6˜,8˜	Intermediate value between two adjacent judgments		

Source: Mon et al., 1994 and Hsieh et al., 2004

C. *Fuzzy analytic hierarchy process (FAHP)*

Reference [25] proposed FAHP, which is an application of the combination of AHP and Fuzzy Theory. FAHP converts the opinions of experts from previous definite values to fuzzy numbers and membership functions. It also generalizes the calculation of the consistent ratio (CR) into a fuzzy matrix. Many researches have been done with the application of fuzzy AHP, and different fuzzy AHP models were constructed [10, 12-14, 20, 26-28].

The procedure of FAHP for determining the evaluation weights involve eight essential steps summarized as follows [9]:

Step 1. Establish a hierarchy scheme for the criteria to be weighted. Based on linguistic variables and for each level in the hierarchy a pairwise comparison questionnaire is created. Each decision maker is asked to express relative importance of two elements in the same level by a nine-point scale.

Step 2. After pairwise comparisons are finished at a level, a fuzzy reciprocal judgment matrix $\tilde{A}^k$ of decision maker k can be established as

$$\tilde{A}^k = [\tilde{a}_{ij}]^k = \begin{bmatrix} a11 & a12 & ... & a1n \\ a21 & a22 & ... & a2n \\ . & . & . & . \\ an1 & an2 & ... & ann \end{bmatrix}^k \quad (9)$$

where n is the number of the related elements at this level, and $\tilde{a}_{ij} = 1/\tilde{a}_{ji}$

Step 3. Construct fuzzy positive matrices. The scores of pairwise comparison are transformed into linguistic variables, which are represented by positive triangular fuzzy numbers listed in Table II. According to [27] the fuzzy positive reciprocal matrix can be defined as:

$$\widetilde{R}^k = [\widetilde{r}_{ij}]^k \tag{10}$$

where

$\widetilde{R}^k$: a positive reciprocal matrix of decision maker k;
$\widetilde{r}_{ij}$: relative importance between decision elements i and j;
$\widetilde{r}_{ij} = 1,\ \forall i = j$; and
$\widetilde{r}_{ij} = \frac{1}{\widetilde{r}_{ji}},\ \forall i, j = 1, 2, \ldots, n.$

Step 4. Analyze consistency. The priority of the elements can be compared by the computation of eigenvalues and eigenvectors:

$$R \cdot w = \lambda_{max} \cdot w \tag{11}$$

where w is the eigenvector, the weight vector, of matrix R, and λ_{max} is the largest eigenvalue of R.

The consistency property of the matrix is then checked to ensure the consistency of judgments in the pairwise comparison. The consistency index (CI) and consistency ratio (CR) are defined as [8]:

$$\mathrm{CI} = \frac{\lambda_{max} - n}{n - 1} \tag{12}$$

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}} \tag{13}$$

where n is the number of items being compared in the matrix, and RI is random index, the average consistency index of randomly generated pairwise comparison matrix of similar size, as shown in Table III. As suggested by [29], the upper threshold CR values are 0.05 for a 3 × 3 matrix, 0.08 for a 4 × 4 matrix, and 0.10 for larger matrices. If the consistency test is not passed, the original values in the pairwise comparison matrix must be revised by the decision maker.

TABLE III
RANDOM INDEX (RI) [8]

N	2	3	4	5	6	7	8
RI	0.00	0.58	0.90	1.12	1.24	1.32	1.41
N	10	11	12	13	14	15	
RI	1.19	1.51	1.48	1.56	1.57	1.59	

Step 5. Calculate fuzzy weights. Based on the Lambda–Max method proposed by [30], calculate the fuzzy weights of decision elements. The procedures are:

- Apply α - cut. Let α = 1 to obtain the positive matrix of decision maker k, $\widetilde{R}_b^k = (\widetilde{r}_{ij})_b^k$, and let α = 0 to obtain the lower bound and upper bound positive matrices of decision maker k, $\widetilde{R}_a^k = (\widetilde{r}_{ij})_a^k$ and $\widetilde{R}_c^k = (\widetilde{r}_{ij})_c^k$. Based on the weight calculation procedure proposed in AHP, calculate weight matrix, $W_b^k = (w_i)_b^k, W_a^k = (w_i)_a^k$ and $W_c^k = (w_i)_c^k$, $i = 1, 2, \ldots, n$.
- In order to minimize the fuzziness of the weight, two constants, M_a^k and M_c^k, are chosen as follows:

$$M_a^k = \min\left\{\frac{w_{ib}^k}{w_{ia}^k} | 1 \leqslant i \leqslant n\right\} \tag{14}$$

$$M_c^k = \max\left\{\frac{w_{ib}^k}{w_{ic}^k} | 1 \leqslant i \leqslant n\right\} \tag{15}$$

The upper bound and lower bound of the weight are defined as

$$w_{ia}^{*k} = M_a^k w_{ia}^k \tag{16}$$

$$w_{ic}^{*k} = M_c^k w_{ic}^k \tag{17}$$

The upper bound and lower bound weight matrices are

$$W_a^{*k} = (w_i^*)_a^k, \quad i = 1, 2, \ldots, n \tag{18}$$

$$W_c^{*k} = (w_i^*)_c^k, \quad i = 1, 2, \ldots, n \tag{19}$$

- By combining W_a^{*k}, W_b^k and W_c^{*k}, the fuzzy weight matrix for decision maker k can be obtained and is defined as $\widetilde{W}_i^k = (w_{ia}^{*k}, w_{ib}^k, w_{ic}^{*k}), i = 1, 2, \ldots, n$.

Step 6. Integrate the opinions of decision makers. Geometric average is applied to combine the fuzzy weights of decision makers

$$\overline{\widetilde{W}}_i = \left(\prod_{k=1}^{K} \widetilde{W}_i^k\right)^{\frac{1}{K}}, \quad \forall\ k = 1, 2, \ldots, K \tag{20}$$

where

$\overline{\widetilde{W}}_i$: combined fuzzy weight of decision element i of K decision makers.
$\widetilde{W}_i^k$: fuzzy weight of decision element i of decision maker k.
K: number of decision makers.

Step 7. Obtain local weights. Based on the equation proposed by [22], a closeness coefficient is defined to obtain the ranking order of the decision elements. The closeness coefficient is defined as follows:

$$\mathrm{CC}_i = \frac{d^-\left(\overline{\widetilde{W}}_i, 0\right)}{d^*\left(\overline{\widetilde{W}}_i, 1\right) + d^-\left(\overline{\widetilde{W}}_i, 0\right)}, \quad i = 1, 2, \ldots, n$$
$$0 \leqslant \mathrm{CC}_i \leqslant 1 \tag{21}$$

where CCi is the weight for decision element i, and

$$d^-\left(\overline{\widetilde{W}}_i, 0\right) = \sqrt{\frac{1}{3}[(\overline{W}_{ia} - 0)^2 + (\overline{W}_{ib} - 0)^2 + (\overline{W}_{ic} - 0)^2]}$$

$$d^*\left(\overline{\widetilde{W}}_i, 1\right) = \sqrt{\frac{1}{3}[(\overline{W}_{ia} - 1)^2 + (\overline{W}_{ib} - 1)^2 + (\overline{W}_{ic} - 1)^2]}$$

$d^-\left(\overline{\widetilde{W}}_i, 0\right)$ and $d^*\left(\overline{\widetilde{W}}_i, 1\right)$ are the distance measurement between two fuzzy numbers.

The local weight ω_i for decision element I is the normalisation of CC_i, which can be expressed as:

$$\omega_i = \mathrm{CC}_1 / \Sigma \mathrm{CC}_i \tag{22}$$

Step 8. Gain global weights. The global weights of the subcriteria of e-commerce websites can be calculated by multiplying the local weights of the sub-criteria by the corresponding local weights of the criteria.

IV. AN EMPIRICAL EXAMPLE FOR SMES ECOMMERCE WEBSITES PERFORMANCE

The four perspectives of web Marketing mix [7] were taken as the framework for establishing performance evaluation indexes in this research. In this framework, the AHP hierarchy scheme is constructed correspondingly, shown in Fig. 4, the FAHP was then used to obtain the fuzzy weights of the indexes.

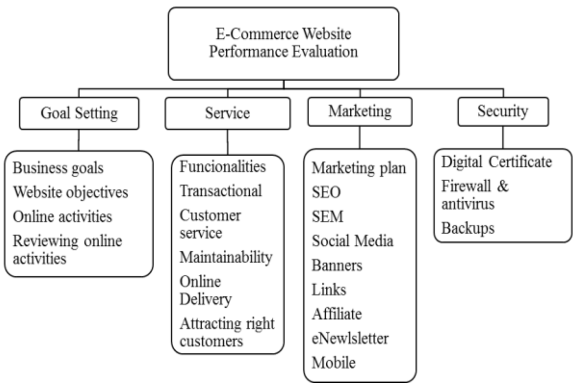

Fig. 4 Hierarchy structure

In this research, we first base on the four Value Proposition criteria to prepare a list of performance evaluation indicators, and then have an interview with six owners of SMEs that are engaged in eCommerce in Abu Dhabi to modify the list. Using a trial version of the software Expert Choice version 11, a questionnaire was then designed with the conventional AHP questionnaire format (nine-point scale and pairwise comparison) based on the hierarchy.

The questionnaire was distributed to the same owners, and the feedbacks were analyzed through Excel sheet to obtain the relative importance of the four criteria and the relative importance of the key performance indicators under each Criterion.

The judgment matrixes according to decision maker 1's opinion are shown in Table III~Table VII. In addition, the CRs of Table III~Table VII were calculated as 0.006, 0, 0.004, 0.011, and 0.022, which show that all of the judgments of decision maker 1 are consistent. The calculated fuzzy weights are shown in the second and third columns of Table 8. Integrating the six responses, we get final fuzzy weights and according to (21) and (22), local weights are obtained in the fourth column of Table 8. Hence, global weights are gained and the priority ranking of sub-criteria is given in the fifth and sixth column of Table8, respectively. Fig 5 shows the global weights of the indicators.

TABLE III
FUZZY COMPARISON MATRIX OF THE CRITERIA-LEVEL USING TRIANGULAR FUZZY NUMBERS

Goal: Website Performance	Goal Setting	Ser vic e	Marke ting	Security
Goal Setting	$\tilde{1}$	$\tilde{2}$	$\tilde{1}$	$\tilde{3}$
Service	$\tilde{2}^{-1}$	$\tilde{1}$	$\tilde{2}^{-1}$	$\tilde{2}$
Marketing	$\tilde{1}$	$\tilde{2}$	$\tilde{1}$	$\tilde{3}$
Security	$\tilde{3}^{-1}$	$\tilde{2}^{-1}$	$\tilde{3}^{-1}$	$\tilde{1}$

Table IV
FUZZY COMPARISON MATRIX OF THE SUBCRITERIA-LEVEL WITH RESPECT TO THE FIRST CRITERION-TECHNIQUE USING TRIANGULAR FUZZY NUMBERS

Goal Setting	Business Goals	Website objectives	Online activities	Reviewing online activities
Business Goals	$\tilde{1}$	$\tilde{2}$	$\tilde{2}$	$\tilde{4}$
Website objectives	$\tilde{2}^{-1}$	$\tilde{1}$	$\tilde{2}$	$\tilde{4}$
Online activities	$\tilde{2}^{-1}$	$\tilde{2}^{-1}$	$\tilde{1}$	$\tilde{2}$
Reviewing online activities	$\tilde{4}^{-1}$	$\tilde{4}^{-1}$	$\tilde{2}^{-1}$	$\tilde{1}$

TABLE V
FUZZY COMPARISON MATRIX OF THE SUBCRITERIA-LEVEL WITH RESPECT TO THE SECOND CRITERION-DESIGN USING TRIANGULAR FUZZY NUMBERS

Service	Functionalities	Transactional	Customer service	Maintainability	Online delivery	Right customers
Functionalities	1~	2~ -1	1~	2~ -1	2~	2~
Transactional	2~	1~	2~	1~	2~	2~
Customer service	2~ -1	2~ -1	1~	3~ -1	2~	2~
Maintainability	2~	1~	3~	1~	4~	4~
Online Delivery	2~ -1	2~ -1	2~ -1	4~ -1	1~	2~
Right customers	$\tilde{2}^{-1}$	$\tilde{2}^{-1}$	$\tilde{2}^{-1}$	$\tilde{4}$	$\tilde{2}^{-1}$	$\tilde{1}$

TABLE VI
FUZZY COMPARISON MATRIX OF THE SUBCRITERIA-LEVEL WITH RESPECT TO THE THIRD CRITERION-INFORMATION USING TRIANGULAR FUZZY NUMBERS

Marketing	Plan	SEO	SEM	SM	Banner	Affiliate	links	eLetter	Mobile
Plan	$\tilde{1}$	$\tilde{2}^{-1}$	$\tilde{2}^{-1}$	$\tilde{2}^{-1}$	$\tilde{2}$	$\tilde{2}$	$\tilde{2}$	$\tilde{2}$	$\tilde{2}$
SEO	$\tilde{2}$	$\tilde{1}$	$\tilde{3}$	$\tilde{2}$	$\tilde{4}$	$\tilde{4}$	$\tilde{4}$	$\tilde{4}$	$\tilde{5}$
SEM	$\tilde{2}$	$\tilde{3}^{-1}$	$\tilde{1}$	$\tilde{2}^{-1}$	$\tilde{2}$	$\tilde{3}$	$\tilde{3}$	$\tilde{3}$	$\tilde{3}$
SM	$\tilde{2}$	$\tilde{2}^{-1}$	$\tilde{2}$	$\tilde{1}$	$\tilde{3}$	$\tilde{3}$	$\tilde{3}$	$\tilde{3}$	$\tilde{4}$
Banner	$\tilde{2}^{-1}$	$\tilde{4}^{-1}$	$\tilde{2}^{-1}$	$\tilde{3}^{-1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{2}$
Affiliate	$\tilde{2}^{-1}$	$\tilde{4}^{-1}$	$\tilde{3}^{-1}$	$\tilde{3}^{-1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{2}$	$\tilde{1}$	$\tilde{1}$
Links	$\tilde{2}^{-1}$	$\tilde{4}^{-1}$	$\tilde{3}^{-1}$	$\tilde{3}^{-1}$	$\tilde{1}$	$\tilde{2}^{-1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$
eLetter	$\tilde{2}^{-1}$	$\tilde{4}^{-1}$	$\tilde{3}^{-1}$	$\tilde{3}^{-1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$
Mobile	$\tilde{2}^{-1}$	$\tilde{5}^{-1}$	$\tilde{3}^{-1}$	$\tilde{4}^{-1}$	$\tilde{2}^{-1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$	$\tilde{1}$

TABLE VII
FUZZY COMPARISON MATRIX OF THE SUBCRITERIA-LEVEL WITH RESPECT TO THE LAST CRITERION-SERVICE USING TRIANGULAR FUZZY NUMBERS

Security	Digital certificates	Firewall& antivirus	Backups
Digital certificates	$1^{\sim}$	$2^{\sim}$	$2^{\sim}$
Firewall& antivirus	$2^{\sim -1}$	$1^{\sim}$	$2^{\sim}$
Backups	$2^{\sim -1}$	$2^{\sim -1}$	$1^{\sim}$

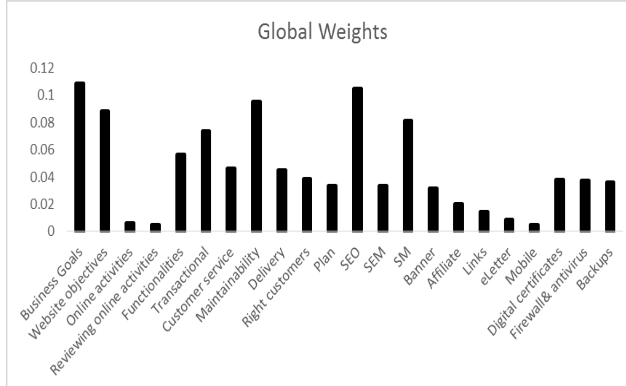

Fig. 5 Global weights of all indicators

TABLE VIII
OVERALL RESULTS COMPUTED BY FAHP

	Fuzzy weights (λ_{max} method) $\alpha = 0$	$\alpha = 1$	Local weights	Global weights	rank
Business Goals	[0.290308,0.391382]	0.363636	0.264048	0.10896	1
Website objectives	[0.181818,0.181818]	0.181818	0.214311	0.088436	4
Online activities	[0.036778,0.036778]	0.036778	0.015199	0.006272	20
Reviewing online activities	[0.061657,0.076032]	0.067833	0.012727	0.005252	21
Functionalities	[0.227802,0.317058]	0.27714	0.403659	0.056285	7
Transactional	[0.181818,0.181818]	0.181818	0.529271	0.0738	6
Customer service	[0.131886,0.145287]	0.133603	0.332968	0.046428	8
Maintainability	[0.465819,0.465819]	0.465819	0.682509	0.095167	3
Delivery	[0.368040,0.410053]	0.410053	0.323565	0.045117	9
Right customers	[0.211683,0.233667]	0.221486	0.278326	0.038809	10
Plan	[0.140705,0.188805]	0.16107	0.163719	0.033603	14
SEO	[0.181818,0.181818]	0.181818	0.511903	0.105067	2
SEM	[0.284052,0.371856]	0.345849	0.163388	0.033535	15
SM	[0.219204,0.287694]	0.253122	0.397660	0.081619	5
Banner	[0.131886,0.145287]	0.133603	0.154345	0.031679	16
Affiliate	[0.093140,0.106943]	0.09597	0.098388	0.020194	17
Links	[0.092172,0.120640]	0.106567	0.070700	0.014511	18
eLetter	[0.061657,0.076032]	0.067833	0.043299	0.008887	19
Mobile	[0.036778,0.036778]	0.036778	0.024950	0.005121	22
Digital certificates	[0.069618,0.082475]	0.069618	0.155855	0.03782	11
Firewall& antivirus	[0.211683,0.233667]	0.221486	0.154219	0.037423	12
Backups	[0.085601,0.121057]	0.090909	0.149937	0.036384	13
Goal Setting	[0.367158,0.454670]	0.45467	0.412652		
Service	[0.141140,0.146668]	0.14114	0.139437		
Marketing	[0.204192,0.308002]	0.263049	0.205248		
Security	[0.141140,0.146668]	0.14114	0.242662		

V. CONCLUSION

The aim of the study was to investigate the importance of eCommerce websites marketing mix and how that can be used to evaluate its performance. Since the issue was seen as a multi-criteria decision making that include fuzziness when assessing the website, FAHP approach deemed useful. In particular, triangular fuzzy numbers was used to improve the degree of judgments of decision makers.

The analytic hierarchy is structured by the four perspectives of the web unique selling proposition for the online space including goal setting, marketing, services, and security followed by their indicators.

An empirical example was carried out to illustrate the applicability of FAHP, which shows how to choose the quantitative weights for making further calculations.

The results show that goal setting (0.413) and marketing (0.205) have higher weightings indicating the importance of having business goals and the need of marketing for eCommerce websites. The results also ranks 22 indicators that can be used for eCommerce websites performance evaluation.

Overall, the results can provide some suggestions to online businesses in developing future online strategies, development objectives and performance evaluation.

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