FAHP-based to-do-list for eCommerce websites the case of SMEs in Abu Dhabi

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Abstract: The continued disappointment among SMEs for their online activities and the subsequent struggle in recognising benefits is a call for action to develop a checklist to guide owners/managers. Based on the web marketing mix, this paper responds to such requirement and develop a prioritised and most important to-do-list that can be used as a guideline for eCommerce website development. Further, the fuzzy analytic hierarchy process (FAHP) approach was used to rank and prioritise the list. The results show 22 items where ‘setting a strategic goal’ and ‘making the website search friendly’ made it to the top of the list. Surprisingly, mobile marketing came last on the list indicating that SMEs in UAE are not yet utilising the power of smartphones for eCommerce purposes.

Keywords: website; eCommerce; website; online business; eCommerce website; offerings; web marketing mix; fuzzy analytic hierarchy process; FAHP; multi-criteria decision making; MCDM; Abu Dhabi.


Biographical notes: Ahmad Ghandour is an Associate Professor of MIS at the Al Ain University of Science and Technology, UAE. He completed his PhD in Information Science from the Otago University, New Zealand. His research interests are in the area of business value of websites, the power of social media in marketing, eCommerce and disaster management, technology acceptance models, electronic, mobile and social commerce, big data and structural equation modelling. His work appeared in various academic journals and presented in many local and international conferences. He serves as a reviewer and a section editor for international journals.

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1 Introduction

Small and medium enterprises (SMEs) are increasingly investing in the web to conduct their business activities as trading online is becoming essential part of today’s business practice. Indeed, eCommerce website have proliferated and used by businesses across all sectors. It is however, not clear what level of success is being experienced by SMEs owner/manager in utilising the web for their eCommerce activities. This may be a self-reinforcing cycle in that many owners have little knowledge of how to create a web marketing mix to drive visitors into their website. Unlike traditional marketing, the web marketing mix emphasises a website that create lasting experience that will create return visitors.

Although creating web marketing mix is not a new practice, many SMEs are still struggling to create a succinct one. A succinct web marketing mix identifies the reason why customers will click on, return, register or buy from the website and feel motivated to share their experience.

As described in the following section, we found a few studies in the literature that identifies the elements of the mix. Given the importance of identifying these elements and in order to improve success, it is first necessary to understand how managers perceive the utilisation of the web marketing mix in their website. As SMEs owner/managers are directly involved in their website investment decisions, they can rely on personal experience when forming an overall perception of performance which can at least help to pinpoint areas within the firm where eCommerce is creating value. This make the owners/managers’ perception for the success of the system being employed is critical.

This research reviews the existing literature on web-marketing mix to create a checklist for managers that enables them to assess their online activities. Whilst the literature provides a useful foundation for creating such a checklist, it introduces fuzziness and vagueness which enhance the difficulty when assessing the website. In addition, the quantisation among criteria lacks the scientific bases leading to abstract results that are difficult to denote the performance of a website. With this gap in mind, this study adapts a fuzzy analytic hierarchy process (FAHP) not only to tolerate vagueness or ambiguity but also to weight evaluation indexes of the web marketing mix as assessing a website is seen as a multi-criteria decision making (MCDM) problem.

FAHP is a well-known method for solving decision-making problems, in which a pair-wise comparison matrix and the eigenvector are derived to specify the weights of each parameter in the problem. The decision maker (DM) performs pair-wise comparisons and the weights guide the DM in choosing the superior alternative.

This research aims at answering the following two research questions:

1. What is a typical checklist for an eCommerce website excellence for SMEs?
2. What are the relative importance of the items within the checklist according to experienced SMEs managers?

The rest of the paper is organised as follows: Section 2 present the marketing mix 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 Section 5.
2 Marketing mix for the online space

Setting up a website to sell goods/services requires businesses to understand requirements for the online space that might be different to the traditional way of doing business. However, creating a website according to Thelwall (2001) is a business issue rather than a technical task. While the basics of doing business are the same, implementing at the web is different story (Porter, 2001). According to Zhu and Kraemer (2003), businesses invest in their websites to reflect their strategic initiative to use the web to engage with customers. When a business decides to go online, its presence must be appropriate to the needs of the business and should focus on supporting its business goals. Constantinides (2002) argued that the 4Ps paradigm is a poor choice in the case of online marketing and suggested a web-marketing mix framework as an alternative.

Krishnamurthy (2003) proposed an internet toolkit with 6Cs when conducting business online. These are: commerce (placing order and making payment online), communication, connectivity (reaching any user that is connected to the internet), community (through social media networks), content (detailed information), and computing (e.g., order tracking).

In the online environment, however, users are using eCommerce websites for informational, transactional and/or services purposes (Deans and Adam, 2000; Molla and Licker, 2001). In general, selling involves creating content that confers excellence and produces customer appeal. According to Choi and Jin (2015), content implies informational, design and technology. A website for eCommerce is a transactional one as it sells its products/services online. In addition, such a website serves as a communication channel for bidirectional information transfer and communication, a platform for transacting, an interface for providing customer service, and a facilitator for marketing initiatives. Hence, businesses need to deliver these functions in a way that it helps the visitors and thus, affects their view of its effectiveness.

Another requirement for the online environment is to make the website visible and easier to find for existing and potential customers. The right internet marketing strategy drives visitors to the website (Knežević and Vidas-Bubanja, 2010). While there are many techniques SMEs can utilise, search engine optimisation (SEO), search engine marketing (SEM) and social marketing are likely to be used by owners/managers when maintaining and managing website (Shih et al., 2013).

Online trading also brings the security issue on board. Despite various technical advancements, internet security still remain one of the major barriers to eCommerce website (Turban and Gehrke, 2000). Owners/managers may need to be active with securing their server and protect it with firewall and antivirus. Digital certificate is also another requirement to secure confidential data, such as credit card numbers (Wang et al., 2016).

A website for eCommerce can therefore be created by assigning a mix of the above requirements which managers may leverage to satisfy market needs. The outcome is a website with offerings that is differentiated from competitors’ websites, able to create awareness, generate traffic, and drive sales.

The extant literature identifies the web marketing mix and the relationships to purchase intention (Ranganathan and Ganapathy, 2002; Sam and Chatwin, 2005, 2010; Walia and Zahedi, 2013). However, measuring the effectiveness of such offerings is still a struggle and an evaluative checklist is still a top priority for SMEs owners/managers.
Different frameworks that have emerged from different theoretical backgrounds and have been informed by somewhat dissimilar goals have been used as the basis for website evaluation effort in the context of SMEs.

Ghandour et al. 2013 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 perspectives and establishes a method for ensuring a website excellence (Ghandour, 2015). These are:

- **Goal setting**: defining the website’s purpose and audience is the first step towards effective performance. A successful website is one that helps meet business goals. Each section of the website works not only toward meeting at least one of the business goals but also must have a purpose that is clearly understood by the site visitor. Purpose defines the ‘look and feel’ and the content of the section which will help the site visitor understand what the site is about. Subsequently, the website will attract the right customers.

- **Marketing**: non visitors to the website need to learn about it in order to make a visit. Online and offline marketing effort are often attempted to attract visitors to the website. Social media and mobile marketing are becoming popular in reaching out to the customers. Email campaign is also used for the same purpose. Most of these efforts are made organically without any cost. Paid services, however, becomes necessary if competitors are ranking a head.

- **Security**: eCommerce websites are vulnerable to security threats and a security breach is one of the main reasons to make visitors abandon online shopping. Internet uses protocols for transferring information from the user’s browser to the hosting servers that are not secure. eCommerce website deals with financial information of its online buyers and hence must have security protocols to protect such information. The secure socket layer is the standard form of security usually used. Every eCommerce website must have its own SSL certificates. Other measures of precautions include antivirus, firewall and backups are usually taken by SMEs to instil confidence and trust in customers visiting the websites.

- **Service**: websites need to provide more than security to enhance the shopping experience to their visitors. Website for example needs not only to organise and structure its information to be visualised and expressed on detailed pages but also easy to be found. Shipping method and delivery of information play important role of enhancing user experience. The buying experience must then be apparent in the eCommerce website. The checkout process should be easy and a payment gateway allowing different types of payments processed easily and quickly to the merchant account.

3 **Methodology**

The primary objective behind this initial classification, which represents a modification of the taxonomy developed by Ghandour et al. (2013), was to establish a checklist from which owners/managers can drive their eCommerce strategy. Overall, four website perspectives have been identified in relation to its offerings: goal setting, service,
marketing, and security. According to the initial taxonomy presented above, the success of an eCommerce website lies in the ability to perform these tasks at various points in time, in order to develop the appropriate palliative strategies that could enhance them, and ultimately improve chances of success.

As SMEs owner/managers are directly involved in their website investment decisions, they can rely on personal experience when forming an overall perception of performance which can at least help to pinpoint areas within the firm where eCommerce is creating value. This makes the owners/managers’ perception for the success of the system being employed is critical.

The overall objective of this study is to build an authoritative list of typical elements of ensuring website offerings excellence and determine the relative importance of these elements. The four perspectives of web marketing mix (Ghandour et al., 2013) were taken as the framework for establishing performance evaluation indexes for this research. 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 MCDM, a FAHP approach is used to rank element, which can tolerate vagueness and uncertainty of judgement. The analytic hierarchy process (AHP) hierarchy scheme is constructed correspondingly, shown in Figure 1, the FAHP was then used to obtain the fuzzy weights of the indexes (Appendix) shows the details of how ‘The FAHP’ works.

**Figure 1**  Hierarchy structure

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4 **An empirical example for SMEs eCommerce website performance**

In this research, we first base on the four marketing mix 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
FAHP-based to-do-list for eCommerce websites the case of SMEs

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 FAHP approach was borrowed from Yi-Wen et al. (2007) as shown in Appendix, as follows: The pairwise comparison results of DMs filled on the questionnaires are then input by selecting the number on the nine-point scale as is shown in Table 2. With reference to the FAHP methodology as explained in Appendix, maximum eigenvalue of the matrix is calculated by equation (11) (Appendix A3) and the consistency property of the matrix is checked by equations (12) and (13) (Appendix A3). If the consistency test is not passed, the questionnaire can either be revised by the DM or be disregarded. Fuzzy positive matrices based on the input questionnaire results are generated next by equation (10) and equations (14) to (19) (Appendix A3), are adopted next to calculate the comparison weights of decision elements. The fuzzy weights from different DMs are finally combined by equation (20) (Appendix A3), to generate the overall fuzzy matrix, as shown in Table 6. The final priority weights and ranking are obtained by equation (21) (Appendix A3).

The questionnaire was distributed to the same owners, the responses collected were input to the FAHP system, and the feedbacks were analysed by FAHP to obtain the relative importance of the four criteria and the relative importance of the key performance indicators under each criterion.

5 Results

The judgement matrixes according to DM 1’s opinion are shown in Table 1~Table 5. Table 1 shows the fuzzy comparison matrix of the criteria-level using triangular fuzzy numbers. Tables 2–5 show the fuzzy comparison matrix of the subcriteria-level with respect to the criterion-level using triangular fuzzy numbers. In addition, the CRs of Table 1~Table 5 were calculated as 0.006, 0, 0.004, 0.011, and 0.022, which show that all of the judgements of DM 1 are consistent. The calculated fuzzy weights are shown in the second and third columns of Table 6. 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 6. Hence, global weights are gained and the priority ranking of subcriteria is given in the fifth and sixth column of Table 8, respectively. Figure 2 shows the global weights of the indicators. Figure 3 shows all indicators ordered.

Table 1 Criteria-level matrix

<table>
<thead>
<tr>
<th></th>
<th>Goal: website performance</th>
<th>Goal setting</th>
<th>Service</th>
<th>Marketing</th>
<th>Security</th>
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</thead>
<tbody>
<tr>
<td>Goal setting</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Service</td>
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<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Marketing</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Security</td>
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<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Table 2  Subcriteria-level of the first criterion-goal setting

<table>
<thead>
<tr>
<th>Goal setting</th>
<th>Business goals</th>
<th>Website objectives</th>
<th>Online activities</th>
<th>Attracting right customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business goals</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Website objectives</td>
<td>2⁻¹</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Online activities</td>
<td>2⁻¹</td>
<td>2⁻¹</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Attracting right customers</td>
<td>4⁻¹</td>
<td>4⁻¹</td>
<td>2⁻¹</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 3  Subcriteria-level with respect to the second criterion-service

<table>
<thead>
<tr>
<th>Service</th>
<th>Product detailed pages</th>
<th>Search and filtering tools</th>
<th>Shipping</th>
<th>Maintainability</th>
<th>Checkout</th>
<th>Payments gateway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product detailed pages</td>
<td>1</td>
<td>2⁻¹</td>
<td>1</td>
<td>2⁻¹</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Search and filtering tools</td>
<td>2⁻¹</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Shipping</td>
<td>2⁻¹</td>
<td>2⁻¹</td>
<td>1</td>
<td>3⁻¹</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Maintainability</td>
<td>2⁻¹</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>4⁻¹</td>
<td>1</td>
</tr>
<tr>
<td>Checkout</td>
<td>2⁻¹</td>
<td>2⁻¹</td>
<td>2⁻¹</td>
<td>4⁻¹</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Payments gateway</td>
<td>2⁻¹</td>
<td>2⁻¹</td>
<td>2⁻¹</td>
<td>4</td>
<td>2⁻¹</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 2  Global weights of all indicators
Table 4  Subcriteria-level with respect to the third criterion—marketing

<table>
<thead>
<tr>
<th>Marketing</th>
<th>PM</th>
<th>SEO</th>
<th>SEM</th>
<th>SM</th>
<th>Banner</th>
<th>Affiliate</th>
<th>EC</th>
<th>eLetter</th>
<th>Mobile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printed material</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>SEO</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>SEM</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>SM</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Banner</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Affiliate</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Email campaign</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>eLetter</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Mobile</td>
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<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: PM: printed material; EC: email campaign.

Figure 3  All indicators ordered

Table 5  Subcriteria-level with respect to the last criterion—security

<table>
<thead>
<tr>
<th>Security</th>
<th>Digital certificates</th>
<th>Firewall and antivirus</th>
<th>Backups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital certificates</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Firewall and antivirus</td>
<td>2⁻¹</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Backups</td>
<td>2⁻¹</td>
<td>2⁻¹</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 6  Overall results computed by FAHP

<table>
<thead>
<tr>
<th></th>
<th>Fuzzy weights ($\lambda_{\text{max}}$ method)</th>
<th>Local weights</th>
<th>Global weights</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\alpha = 0$</td>
<td>$\alpha = 1$</td>
<td></td>
<td></td>
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<tr>
<td>Business goals</td>
<td>[0.290308, 0.391382]</td>
<td>0.363636</td>
<td>0.264048</td>
<td>0.10896 1</td>
</tr>
<tr>
<td>Website objectives</td>
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<td>0.27714</td>
<td>0.403659</td>
<td>0.056285 7</td>
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<td>Online activities</td>
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<td>0.036778</td>
<td>0.015199</td>
<td>0.006272 20</td>
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<tr>
<td>Right customers</td>
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<td>0.067833</td>
<td>0.012727</td>
<td>0.005252 21</td>
</tr>
<tr>
<td>Printed materials</td>
<td>[0.140705, 0.188805]</td>
<td>0.16107</td>
<td>0.163719</td>
<td>0.033603 14</td>
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<tr>
<td>SEO</td>
<td>[0.181818, 0.181818]</td>
<td>0.181818</td>
<td>0.511903</td>
<td>0.105067 2</td>
</tr>
<tr>
<td>SEM</td>
<td>[0.284052, 0.371856]</td>
<td>0.345849</td>
<td>0.163388</td>
<td>0.033535 15</td>
</tr>
<tr>
<td>SM</td>
<td>[0.219204, 0.287694]</td>
<td>0.253122</td>
<td>0.397660</td>
<td>0.081619 5</td>
</tr>
<tr>
<td>Banner</td>
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<td>0.133603</td>
<td>0.154345</td>
<td>0.031679 16</td>
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<td>0.098388</td>
<td>0.020194 17</td>
</tr>
<tr>
<td>Email campaign</td>
<td>[0.092172, 0.120640]</td>
<td>0.106567</td>
<td>0.070700</td>
<td>0.045111 18</td>
</tr>
<tr>
<td>eLetter</td>
<td>[0.061657, 0.076032]</td>
<td>0.067833</td>
<td>0.043299</td>
<td>0.008887 19</td>
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<tr>
<td>Mobile</td>
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<td>0.024950</td>
<td>0.005121 22</td>
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<td>0.095167 3</td>
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<td>Firewall and antivirus</td>
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<td>0.154219</td>
<td>0.037423 12</td>
</tr>
<tr>
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<td>0.036384 13</td>
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<td>0.332968</td>
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</tr>
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<td>0.181818</td>
<td>0.214311</td>
<td>0.088436 4</td>
</tr>
<tr>
<td>Payments gateway</td>
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<td>0.410053</td>
<td>0.323565</td>
<td>0.045117 9</td>
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<td>Shipping and delivery</td>
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<td>0.221486</td>
<td>0.278326</td>
<td>0.038809 10</td>
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<td>0.412652</td>
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<td>0.139437</td>
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<td>[0.204192, 0.308002]</td>
<td>0.263049</td>
<td>0.205248</td>
<td></td>
</tr>
</tbody>
</table>

6 Discussion

In this study, 22 indicators in four major criteria that lead to eCommerce website effectiveness in case of Abu Dhabi SMEs were ranked and became prioritised. Our four criteria were sequentially ranked as goal setting, marketing, security and service. However, their indicators were sparingly spaced out. It is noted that the four criteria were ranked in consistent with the purchasing funnel. Website is promoted to none visitors, security creates customer confidence, and service enhance product findability and enable customer decision making.

Overall, the empirical case reveals that goal setting is the most important criteria in which having a business goal is most important indicator and to have a website objective
is the fourth most important. Although this is not a novel finding, it is an issue that has been ignored in many success factors lists (Lorenzini and Cerchiello, 2013; Flavian et al., 2009). Indeed, owners need to ensure that their website objective is properly aligned with the business goals. Business process of the website should be aligned with business goals. Each section of the website works towards meeting at least one of the business goals. Without this alignment website is not going to be helpful to the business. In other words a website can help to grow the business by meeting its goals.

The second most important criteria was marketing. While there are many tools a website can use for its marketing activities, having a search engine-friendly website was found most important which would lead to increased web traffic and more leads (Kohli et al., 2009; Härting et al., 2016). Although this is a task that needs a knowledge on how to use a wide range of variables, it is important that businesses stay as up to date as possible with the latest development in Google’s ever changing algorithms (Baye et al., 2016; Baruchson-Arbib and Bar-IlIan, 2007). The next most important tool for marketing was social media through which SMEs can increase web traffics and leads. This is consistent with (Baghdadi, 2016). Other tools such as SEM (paid marketing), banner, affiliate, email campaign and eLetter were found low in the list of priority. Mobile marketing surprisingly were found the least important. A possible explanation is the confusion with the social marketing. Owners/managers are not paying attention to SMS and mobile marketing is still a challenge for SMEs in Abu Dhabi (Fulgoni and Lipsman, 2016).

The third criteria was the security perspective. Although its indicators were sparingly spaced out, the digital certificate item came third indicating the importance of creating customer confidence when they visit the site for the first time. Doing business online involves some risks that can be encountered by installing secure procedure. While security cannot be ignored, owners/managers regard it as a technical issue that cannot be dealt with in more details than providing what is necessary for the customer to trust the website. According to one of the interviewee managers who stated “maintaining backups, firewall and antivirus, and digital certificates are untouchable requirements for my website.”

The last criteria was service. All constituents, however, were highly ranked on the list. This is in consistent with (Ranganathan and Ganapathy, 2002). According to Hernández et al. (2009) the information provided on the website must be accurate, informative, updated and relevant to customers’ requirements. Maintainability indicator ranked fourth on the global list indicating that owners/managers are paying attention mostly to keep their website up-to-date. This results enhances the customer shopping experience before they move into the buying elements. Our results also indicate that, checkout and payments gateway were the next two items in the list to enhance the buying experience.

7 Conclusions

The aim of the study was to develop a checklist for eCommerce websites which can be used to guide owners/managers to understand a continued challenge of their online venture. Based on the web marketing mix, a summary of considerations for eCommerce websites has been the focus of this paper resulting in a checklist for SMEs’
owners/managers to keep them on the top their online activities. An actionable checklist of 22 items has been identified. The resulting items, however, introduce fuzziness and vagueness and do not consolidate the website offering. For such a reason and because these items can be seen as a MCDM, a FAHP approach was used not only to tolerate vagueness and uncertainty of judgement but also to make the list ordered and prioritised.

The four perspectives of the web marketing mix, goal setting, marketing, services, and security were structured for the analytic hierarchy followed by their 22 indicators. The applicability of such approach was illustrated by an empirical example showing how to choose the quantitative weights for making further calculations.

The highest weighting of the result was the goal setting indicating the importance of having the business goals as a top priority in order for the eCommerce website to succeed. Further, the need of the marketing for the eCommerce website was also reflected in the results and came second in the priority list. Surprisingly, mobile marketing came last on the list indicating the power of mobile marketing is yet to be explored.

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

References


Appendix [Borrowed from Yi-Wen et al. (2007)]

The FAHP

A1 The AHP

The AHP was first introduced to solve the scarce resources allocation and planning needs for the military (Saaty, 1980). Since its introduction, the AHP has become one of the most widely used 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 (Yi-Wen et al., 2007). As demonstrated by Cheng (1999), Chi and Kuo (2001), Kang and Lee (2007), Lee et al. (2006), Murtaza (2003) and Zahedi (1986), the procedures of the AHP involve six essential steps.

A2 Fuzzy set theory

Zadeh in 1965 introduced fuzzy set theory to solve problems involving the absence of sharply defined criteria. 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 (Tsaur et al., 1997; Tsaura et al., 2002). 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 Figure 4, the triangular fuzzy number \( \tilde{M} \) is represented by \((a, b, c)\), and the membership function is defined as:

\[
\mu_{\tilde{M}}(x) = \begin{cases} 
\frac{x-a}{b-a}, & a \leq x \leq b \\
\frac{c-x}{c-b}, & b \leq x \leq c \\
0, & \text{otherwise}
\end{cases}
\]  

with \( \infty < a \leq b \leq c < \infty \).

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 $\alpha$-cut. For a fuzzy number $M$ and any number $\alpha \in [0, 1]$, the $\alpha$-cut, $C(\alpha)$, is the crisp set (Klir and Yan, 1995):

$$C(\alpha) = \{x \mid C(x) \geq \alpha\}$$

(2)

The $\alpha$-cut of a fuzzy number $\tilde{M}$ is the crisp set $\tilde{M}^\alpha$ that contains all the elements of the universal set $U$ whose membership grades in $\tilde{M}$ are greater than or equal to the specified value of $\alpha$, as shown in Figure 5.

**Figure 4** Membership function of a triangular fuzzy number $\tilde{M} = (a, b, c)$

![Figure 4](image1)

**Figure 5** $\alpha$-cut of a triangular fuzzy number $\tilde{M}$

![Figure 5](image2)

By defining the interval of confidence at level $\alpha$, the triangular fuzzy number can be characterised as (Cheng, 1996, 1999; Cheng and Mon, 1994):
The distance between two triangular fuzzy numbers can be defined by the vertex method (Chen, 2000).

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

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

(4)

The main operational laws for two triangular fuzzy numbers \( \tilde{M}_1(a_1, b_1, c_1) \) and \( \tilde{M}_2(a_2, b_2, c_2) \) are as follows (Kaufmann and Gupta, 1991):

\[
\tilde{M}_1 \oplus \tilde{M}_2 = (a_1 + a_2 + b_1 + b_2, c_1 + c_2)
\]

(5)

\[
\lambda \tilde{M}_1 = (\lambda a_1, \lambda b_1, \lambda c_1), \lambda > 0, \lambda \in \mathbb{R}
\]

(6)

\[
\tilde{M}_1^{-1} = \left(\frac{1}{a_1}, \frac{1}{b_1}, \frac{1}{c_1}\right), \text{for } a_1 > 0, b_1 > 0, c_1 > 0
\]

(7)

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 (Adamo, 1980; Lee and Li, 1988). Centroid ranking method is also often used to rank fuzzy numbers (Yager, 1978). Each method has its own advantages and disadvantages (Klir and Yan, 1995).

A good decision-making model needs to tolerate vagueness or ambiguity because fuzziness and vagueness are common characteristics in many decision-making problems (Yu, 2002). Since DMs 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 (Yu, 2002). Since the fuzzy linguistic approach can take the optimism/pessimism rating attitude of DMs into account, linguistic values, whose membership functions are usually characterised by triangular fuzzy numbers, are recommended to assess preference ratings instead of conventional numerical equivalence method (Liang and Wang, 1994). 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, \( \tilde{1} \sim \tilde{9} \), 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 7 and Figure 6 respectively.
Table 7 Membership function of the linguistic scale

<table>
<thead>
<tr>
<th>Fuzzy number</th>
<th>Linguistic scales</th>
<th>TFN ($\tilde{a}_{ij}$)</th>
<th>Reciprocal of a TFN ($\tilde{a}_{ij}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Absolutely important</td>
<td>(7, 9, 9)</td>
<td>(1/9, 1/9, 1/7)</td>
</tr>
<tr>
<td>7</td>
<td>Very strongly important</td>
<td>(5, 7, 9)</td>
<td>(1/9, 1/7, 1/5)</td>
</tr>
<tr>
<td>5</td>
<td>Essentially important</td>
<td>(3, 5, 7)</td>
<td>(1/7, 1/5, 1/3)</td>
</tr>
<tr>
<td>3</td>
<td>Weakly important</td>
<td>(1, 3, 5)</td>
<td>(1/5, 1/3, 1)</td>
</tr>
<tr>
<td>1</td>
<td>Equally important</td>
<td>(1, 1, 3)</td>
<td>(1/3, 1, 1)</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>Intermediate value</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Mon et al. (1994) and Hsieh et al. (2004)

A3 Fuzzy analytic hierarchy process

Laarhoveen and Pedrycz (1983) 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 generalises 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 (Boender et al., 1989; Buckley, 1985; Chen, 1996; Cheng, 1996, 1999; Kang and Lee, 2006; Lee et al., 2006; Murtaza, 2003).

The procedure of FAHP for determining the evaluation weights involve eight essential steps summarised as follows (Yi-Wen et al., 2007):
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 DM 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 judgement matrix $\tilde{A}^k$ of DM $k$ can be established as:

$$\tilde{A}^k = [\tilde{a}_{ij}]^k = \begin{bmatrix} a_{11} & a_{12} & \ldots & a_{1n} \\ a_{21} & a_{22} & \ldots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \ldots & a_{nn} \end{bmatrix}$$

(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 2. According to Buckley (1985) the fuzzy positive reciprocal matrix can be defined as:

$$\tilde{R}^k = [\tilde{r}_{ij}]^k$$

(10)

where

$\tilde{R}^k$ a positive reciprocal matrix of DM $k$

$\tilde{r}_{ij}$ relative importance between decision elements $i$ and $j$

$\tilde{r}_{ij} = 1, \forall i = j$

$\tilde{r}_{ij} = \frac{1}{\tilde{r}_{ij}}, \forall i, j = 1, 2, \ldots, n.$

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

$$Rw = \lambda_{\max} w$$

(11)

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

The consistency property of the matrix is then checked to ensure the consistency of judgements in the pairwise comparison. The consistency index (CI) and consistency ratio (CR) are defined as (Saaty, 1980):

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

(12)

$$CR = \frac{CI}{RI}$$

(13)

where $n$ is the number of items being compared in the matrix, and RI is random index, the average CI of randomly generated pairwise comparison matrix of
similar size, as shown in Table 8. As suggested by Saaty (1994), the upper threshold CR values are 0.05 for a $3 \times 3$ matrix, 0.08 for a $4 \times 4$ 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 DM.

Table 8

<table>
<thead>
<tr>
<th>$N$</th>
<th>$3$</th>
<th>$4$</th>
<th>$5$</th>
<th>$6$</th>
<th>$7$</th>
<th>$8$</th>
<th>$9$</th>
<th>$10$</th>
<th>$11$</th>
<th>$12$</th>
<th>$13$</th>
<th>$14$</th>
<th>$15$</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>0.58</td>
<td>0.90</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
<td>1.19</td>
<td>1.51</td>
<td>1.48</td>
<td>1.56</td>
<td>1.57</td>
<td>1.59</td>
</tr>
</tbody>
</table>

*Source:* Saaty (1980)

Step 5 Calculate fuzzy weights. Based on the Lambda-Max method proposed by Csutora and Buckley (2001), calculate the fuzzy weights of decision elements. The procedures are:

- Apply $\alpha$-cut. Let $\alpha = 1$ to obtain the positive matrix of DM $k$, $\tilde{R}_k^+ = (\tilde{r}_{ij})_k^+$, and let $\alpha = 0$ to obtain the lower bound and upper bound positive matrices of DM $k$, $\tilde{R}_k^- = (\tilde{r}_{ij})_k^-$, and $\tilde{R}_k^+ = (\tilde{r}_{ij})_k^+$. Based on the weight calculation procedure proposed in AHP, calculate weight matrix, $W_k^+ = (w_i)_k$, $W_k^- = (w_i)_k^-$ and $W_k^* = (w_i)_k^*$, $i = 1, 2, \ldots, n$.

- In order to minimise the fuzziness of the weight, two constants, $M_k^+$ and $M_k^-$, are chosen as follows:

$$M_k^+ = \min \left\{ \frac{w_{ik}^+}{w_{ia}^+} | \ 1 \leq i \leq n \right\}$$  

$$M_k^- = \max \left\{ \frac{w_{ic}^-}{w_{ic}^-} | \ 1 \leq i \leq n \right\}$$  

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

$$w_{ik}^+ = M_k^+ w_{ia}^+$$  

$$w_{ik}^- = M_k^- w_{ic}^-$$  

The upper bound and lower bound weight matrices are:

$$W_{ik}^+ = (w_i)_k^+$$  

$$W_{ik}^- = (w_i)_k^-$$  

- By combining $W_{ik}^+$, $W_{ik}^-$ and $W_{ik}^*$, the fuzzy weight matrix for DM $k$ can be obtained and is defined as $(W_{ik}^+, W_{ik}^-, W_{ik}^*)$, $i = 1, 2, \ldots, n$. 

Step 6  Integrate the opinions of DMs. Geometric average is applied to combine the fuzzy weights of DMs:

$$\bar{W}_i = \left( \prod_{k=1}^{K} \tilde{W}_i^k \right)^{\frac{1}{K}}, \forall k = 1, 2, \ldots, K$$  \hspace{1cm} (20)

where:
- $\bar{W}_i$ combined fuzzy weight of decision element $i$ of $K$ DMs
- $\tilde{W}_i^k$ fuzzy weight of decision element $i$ of DM $k$
- $K$ number of DMs.

Step 7  Obtain local weights. Based on the equation proposed by Chen (2000), a closeness coefficient is defined to obtain the ranking order of the decision elements. The closeness coefficient is defined as follows:

$$CC_i = \frac{d^-(\bar{W}_i, 0)}{d^-(\bar{W}_i, 1) + d^-(\bar{W}_i, 0)}, \ i = 1, 2, \ldots, n$$ \hspace{1cm} (21)

where $CC_i$ is the weight for decision element $i$, and:

$$d^-(\bar{W}_i, 0) = \frac{1}{\sqrt{3}} \left[ (\bar{w}_a - 0)^2 + (\bar{w}_b - 0)^2 + (\bar{w}_c - 0)^2 \right]$$

$$d^+(\bar{W}_i, 1) = \frac{1}{\sqrt{3}} \left[ (\bar{w}_a - 1)^2 + (\bar{w}_b - 1)^2 + (\bar{w}_c - 1)^2 \right]$$

$d^-(\bar{W}_i, 0)$ and $d^+(\bar{W}_i, 1)$ are the distance measurement between two fuzzy numbers.

The local weight $\omega_i$ for decision element $i$ is the normalisation of $CC_i$, which can be expressed as:

$$\omega_i = CC_i / \Sigma CC_i$$  \hspace{1cm} (22)

Step 8  Gain global weights. The global weights of the subcriteria of eCommerce websites can be calculated by multiplying the local weights of the subcriteria by the corresponding local weights of the criteria.