A Web-Enabled Intelligent Approach towards Digital Marketing Planning: The Integrated System and Its Effectiveness

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Abstract: Formulating a sound digital marketing strategy is a challenging task. A Web-enabled hybrid intelligent approach that combines online simulation, fuzzy logic, if-then rules and Web databases in support of digital marketing strategy formulation is proposed and presented in this paper. The effectiveness of the Web-based integrated system is assessed through case study evaluation work, with initial results reported.

Key-words: World Wide Web; digital marketing strategy; Monte Carlo simulation; Web-based decision support systems; fuzzy logic; expert system

1 INTRODUCTION
Kierzkowski, Mcquade, Waitman and Zeisser [5] advise that companies must combine interactive media with their existing businesses and marketing programmes in order to gain the benefits of digital marketing. In addition to the use of the Internet or Web, digital marketing also employs wider range of digital channels such as mobile phones, wireless communications and digital TV for marketing.

Digital marketing strategy formulation can be defined as the process of devising the methods or means for attaining the digital marketing objectives [5, 10]. Due to the internal and external uncertainty, complexity and the interaction of many different variables or factors, formulating a sound and viable digital marketing strategy can be a challenging job. To tackle this problem effectively, a hybrid or integrated approach that integrates the strengths or powers of various decision support techniques and artificial intelligence technologies may have a role to play in improving the process and outcomes of digital marketing planning.

In the past decades, the development and use of hybrid intelligent systems for strategic marketing planning have been pioneered by some researchers. Representative work in this field are summarised below. Duan and Burrell [3] designed a hybrid system linking the analytic hierarchy process (AHP) and an expert system for setting marketing strategies using a four-cell portfolio matrix. Li [7] developed a hybrid intelligent system that combines artificial neural networks, fuzzy logic and an expert system for formulating marketing strategies based upon various analytical models. Li [8] put forward and tested a hybrid approach integrating group Delphi with a Web-based expert system for strategic marketing planning. Li and Li [11] proposed and evaluated an integrated approach that hybridises human judgement, AHP, simulation and a fuzzy expert system for marketing strategy formulation under uncertainty. Li [9] constructed intelligent software agents for strategic decision making. Li and Li [13] created a hybrid system that unites the powers of multiple intelligent agents, Monte Carlo simulation, fuzzy logic and knowledge bases for international marketing planning. Li and Li [14] originated a Web-based hybrid system that joins Web knowledge automation, fuzzy logic and on-line databases for international marketing decision making.
The above-mentioned systems, nevertheless, were developed to deal with conventional marketing strategy development issues or support general international marketing planning. Extensive literature search indicates that no previous research on the development and evaluation of hybrid intelligent systems for digital marketing planning has been reported.

This paper is particularly concerned with building and evaluating a Web-based hybrid intelligent system for digital marketing strategy formulation. The following section presents the architecture and associated functional components for the Web-enabled integrated system for digital marketing planning. The evaluation findings for the Web-based approach for digital marketing planning are reported in Section 3. The final section provides concluding remarks.

1 WEBDIGITAL: A WEB-ENABLED HYBRID KNOWLEDGE AUTOMATION SYSTEM FOR DIGITAL MARKETING PLANNING

The key ideas behind developing Web-based hybrid knowledge automation decision support are: to enable decision makers to access digital marketing planning expertise, guidelines and analytical models at any time zone and in any geographical places across the world over the Internet; to automate intelligent reasoning and on-line advisory process through a Web-based intelligent system; and to integrate the powers and benefits of various decision support techniques and artificial intelligence technologies, in order to produce effective support for digital marketing strategy formulation.

A system entitled as WebDigital was created by the first and second named authors using the following open source software tools: JSON (JavaScript Object Notation), HTML (HyperText Markup Language), PHP (Hypertext Preprocessor), and the Web-based MySQL relational database management system. The WebDigital system is based on the client-server architecture, with server-side software development and implementation.

WebDigital is designed to: simulate and evaluate relevant factors or variables determining digital marketing strategy formulation; and calculate, reason and advise digital marketing strategies.

The system architecture is shown in Fig.1.
**WebDigital** is composed of various elements: the Web-enabled user interface, the Web-enabled database element, Monte Carlo simulation element, the knowledge base, and the Web-enabled inference.

### 2.1 The Web-enabled user interface
This element is developed to help the dialogue and interactions between the decision maker and the *WebDigital* system. The user will need to provide initial values for the triangular probability functions built in the Monte Carlo simulation components. The system also requests for judgemental inputs or answers to many different questions and variables affecting digital marketing strategy formulation. The system then summarises and aggregates inputs from the user, fuzzifies them using membership functions, performs forward reasoning and produces intelligent advice for general digital marketing strategies, e-mail marketing guidelines and international e-marketing strategies.

### 2.2 The online Monte Carlo simulation element
Monte Carlo simulation is a useful technique for modelling and analysing stochastic behaviour [17]. This element is coded to simulate and investigate the variations and uncertainties with the variable or factors influencing digital marketing. The triangular probability distributions [17] are applied to represent pessimistic, most likely and optimistic scores for the probability distributions. It then influences digital marketing. The triangular probability distributions [17] are applied to represent pessimistic, most likely and optimistic scores for the probability distributions.

### 2.3 The Web-enabled knowledge base
This is programmed to represent “IF … THEN …” rules and fuzzy rules with different levels of certainty or confidence, which symbolises the digital marketing strategy domain expertise, relevant analytical models, e-mail marketing guide and international e-marketing knowledge. Fuzzy logic is coded to describe the ambiguity, uncertainty and confidence levels on associated factors. Trapezoidal membership functions [6, 7, 11] are employed and implemented in the fuzzy rules that estimate the degrees of confidence or certainty for various digital marketing strategy alternatives.

In the knowledge base of *WebDigital*, McDonald [15]’s four-box directional policy matrix for marketing strategy development is adapted and extended to cover digital marketing dimensions and elements including: Varadarajan and Yadav [20]’s advice on developing digital products, on-line price transparency and comparison; short messaging service (SMS) [19], and extensive use of Web sites, e-mails, cookies and software agents for promotion; product/services in search engine natural or organic results listings for selected keywords or phrases [2]; permission and personalisation online [4]; and digital marketing Web sites [2, 19].

Watson and Zinkhan [21]’s four-cell grid is also extended and modified to incorporate guidelines and strategic advice on e-CRM, Web analytics, online customer data mining and market segmentation and marketing planning [2], leveraging the Internet and other digital media for innovation/customisation for products, pricing, promotion and distribution [20], and interactive one-to-one communication, with performance analytics [19].

Expertise about e-mail marketing is based upon Chaffey [1]’s methods for customer e-mail acquisition and retention, capturing e-mail addresses and other profile information for e-mail marketing. Knowledge about e-marketing strategies in international markets is acquired from Sheth and Sharma [18].

### 2.4 The Web-enabled inference
The system employs a search strategy which starts with known facts and tries to infer the conclusions implied by those facts [16]. The chaining control of the *WebDigital* system is programmed using the forward reasoning method and it thus applies user-inputted information, pre-programmed “IF – THEN” rules and fuzzy rules in a data-driven forward thinking way. The system executes on-line reasoning and produces on-line recommendations or advice for digital marketing strategies.

### 2.5 The Web-enabled database element
The Web server-based database components are designed using MySQL relational database management system [22]. It is created to: save Monte Carlo simulation results; store and retrieve the user’s inputs or entries to digital marketing factors or variables during the strategy formulation process. The database element also helps store and retrieve user account information and the facts for reasoning or chaining performed by the inference control components.

A screen snapshot for adapted McDonald [15]’s four-cell matrix with digital marketing elements are shown in Fig. 2.
2 EVALUATION OF THE EFFECTIVENESS OF THE WEBDIGITAL SYSTEM

The effectiveness is assessed using the measures or items summarised by Li and Li [11, 12, 13]. The evaluation study was conducted in the autumn and winter of 2009 with one company managing director, one marketing director, one company systems manager and three university course leaders. The participants were requested to use the Web-based system, WebDigital, to develop and formulate digital marketing strategies for their own cases in their chosen markets for marketing their products, services or university courses though various digital channels. They were then asked to complete an evaluation questionnaire with closed and open-ended questions.

Key replies to the close-ended questions are summarised in Tables 1. Questionnaire survey data in the Table shows that managers’ responses are favourable. The WebDigital system is perceived as effective in helping understand the factors or criteria affecting digital marketing planning, providing on-line planning expertise, recommending relevant options or alternatives, combining Web-based analytical models with human judgement, and improving the quality of digital marketing decision-making.

Table 1. Managers’ responses to the closed questions for measuring effectiveness

<table>
<thead>
<tr>
<th>Measures</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
<th>Score 4</th>
<th>Score 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helping understand the factors that affect digital marketing strategy formulation</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
</tr>
<tr>
<td>Helping decision-making by providing relevant knowledge and guidelines</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
</tr>
<tr>
<td>Helping couple strategic analysis with human judgment</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
</tr>
<tr>
<td>Helping deal with uncertainty in the process of decision-making</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
</tr>
<tr>
<td>Helping generate relevant alternatives or options in the process of decision-making</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
</tr>
<tr>
<td>The quality of the advice produced by the system</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
</tr>
<tr>
<td>Improving the quality of decision-making</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
</tr>
<tr>
<td>Confidence about the advice or recommendations generated by the system</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
<td>♥</td>
</tr>
</tbody>
</table>

Note: The measures listed in the Table use the following scales. For help: 1. no help at all, 2. somewhat helpful, 3. moderately helpful, 4. very helpful, 5. extremely helpful. For quality: 1. low, 2. slightly high, 3. somewhat high, 4. high, 5. very high. For improvement: 1. no improvement, 2. somewhat improvement, 3. moderate improvement, 4. good improvement, 5. significant improvement. For confidence: 1. not confident, 2. slightly confident, 3. somewhat confident, 4. confident, 5. very confident.
Written comments on the support delivered by the WebDigital system are also provided by the participants. Some of the answers to the open-ended questions are quoted below:

“A good aide but no replacement for the skilled expert”

“The output seems very relevant and accurate to my organisation based on the data that I input.”

“The output is quite helpful and I would consider using it as an important tool for decision making.”

“The system helps improve the outcomes of my company’s digital marketing strategy as it considers the various factors that impact on company performance by the use of recognised and relevant models, techniques and technologies.”

3 CONCLUSIONS

The aim of this project has been to investigate the use of Web-based hybrid system in support of digital marketing planning, with first effort made to: integrate the powers of Web enabled knowledge automation, on-line Monte Carlo simulation, databases, “IF – THEN” rules and fuzzy rules for formulating digital marketing strategies; and test the effectiveness of such an approach.

According to the responses from the involved managers, the WebDigital system is evaluated as very useful in: helping consider the variables or factors influencing digital marketing decision making; aiding decision-making by delivering Web-based knowledge, analytical models and guidelines; helping couple Web-enabled knowledge automation with human judgment; helping deal with uncertainty; helping produce relevant alternatives or options in the process of strategy formulation; and helping improve the quality of decision making. In addition, the systems is considered as “a good aide but no replacement for the skilled expert” and “helping improve the outcomes of my company’s digital marketing strategy”

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