Tourism Management 31 (2010) 936–952

Contents lists available at ScienceDirect

Tourism Management

journal homepage: www.elsevier.com/locate/tourman

Case Study

An effective evaluation model and improvement analysis for national park websites: A case study of Taiwan

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ARTICLE INFO

Article history:
Received 22 January 2009
Accepted 23 January 2010

Keywords:
National park
Website evaluation
Decision-Making Trial and Evaluation Laboratory (DEMATEL)
Analytic Network Process (ANP)
VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR)

ABSTRACT

Taiwanese National Park Headquarters employ advanced information technologies to attract travellers, researchers, and other visitors, but it is likely that not all Headquarters have clear knowledge about how successful their websites are. This study proposes an effective model for evaluating national park websites. The model first applies the Decision-Making Trial and Evaluation Laboratory (DEMATEL) to cope with the interdependencies between evaluation criteria. Next, it uses the Analytic Network Process (ANP) to compute weights for each criterion. Finally, it uses the VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) to rank Taiwanese national park websites. Overall, the results show that each national park website must be improved in order to become a high quality website. Furthermore, the weight-variance analysis suggests managerial actions based on two-dimensional maps for improving website quality. Therefore, this study not only provides a comprehensive and systematic approach that quantitatively measures a website's overall performance, but also contributes to practical applications in terms of providing worthwhile recommendations for building an ideal website.

1. Introduction

National parks are repositories of unique natural scenery, cultural assets, and historic resources that are both popular and significant as tourism sites (Ma, Ryan, & Bao, 2009). Taiwanese national parks provide important recreational and tourism-related resources for domestic visitors and international tourists (CCPA, 2008). Following current global trends, and in response to the request of the United Nations, the Taiwanese government chose 2002 as "The Year of Ecotourism in Taiwan," and had promoted ecotourism as a way to attract more foreigners to visit national parks and understand ecology of these places (Tao, Eagles, & Smith, 2004). Specifically, the visitor arrivals to Taiwanese national parks grew 20% within 4 years, from 15,118,078 in 2002 to 18,203,609 in 2006, and the annual growth rates were −2%, 5%, 7%, 10%, respectively (CCPA, 2008). Moreover, the Taiwanese Tourism Bureau had announced 2008 and 2009 as "Tour Taiwan Years" to attract many international tourists to the island. The director of the Taiwanese Tourism Bureau invited international tourists to experience B&B accommodations in a mountain village, along with healthful hiking and eco-explorations. International tourists were also invited to tackle some more challenging outdoor activities, such as climbing the highest mountain (Yushan) in Northeast Asia (Lai, 2008).

The Taiwanese Government has established seven national parks to respond to the growing demand for tourism opportunities and environmental protection. The first Taiwanese national park was established in 1984, and six more parks have been added since that time. Of the seven national parks currently operating in Taiwan, Yushan, Yangmingshan, Taroko, Shei-pa are located in mountainous regions, Kenting and Dongsha Marine near beaches or ocean/marine areas, and Kinmen at a major cultural/historic site. Along with beautiful scenery, they provide shelter to unique animal and plant life, including insects, fish, and birds. The natural reserves actually form miniature ecosystems that not only provide a protected environment but also offer various opportunities for recreational activities, environmental education, and academic research. Here, visitors can escape from their hectic lives in the city and enjoy a serene environment (Tourism Bureau, 2008a). Seven National Park Headquarters were set up to take charge of the substantial resource conservation education and construction management activities in order to promote the parks' sustainable development in a planned manner. The National Park

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doi:10.1016/j.tourman.2010.01.016

Headquarters have given much effort to managing and preserving (or restoring) a natural environment (CCPA, 2008). Through the Headquarters' continuing efforts to develop and promote national parks, Taiwanese national parks are now included in the list of world parks (Hsu, 2007).

Due to the popularity of internet, the National Park Headquarters are able to deliver ecological conservation information, environmental education, and tourism information through their websites. At present, there is a multilingual website for each national park, which provides international visitors with a good deal of information for their travel needs. Computer-mediated tour information, such as traffic, activities, and tour-package information can increase awareness, interest, and the likelihood of visiting a specific travel destination (Ho & Chou-Yen, 2003). Moreover, the content of tourism destination websites is particularly important because it directly leads to the creation and communication of the destination's perceived image, which produces a virtual experience for visitors (Doolin, Burgess, & Cooper, 2002). The National Park Headquarters do not, however, understand how successful their websites are or how many gaps should be filled between the status quo and an ideal website. In other words, how much effort must the Headquarters put into improving or enhancing website quality in order to achieve their desired/aspired ends? This raises the critical issue of how the national park managers can effectively measure their websites' performance. An evaluation is required to answer this question, and a sound methodology is the key to effective measurement. No comprehensive mechanism for systematically assessing the various elements of a website, however, has yet been introduced. Moreover, existing methods do not offer enough insights for practitioners to determine whether their websites meet ideal levels in terms of design and content.

In this vein, this study aims to build an effective model for evaluating national park websites, and then prioritize improvement actions in order to best allocate available resources. To achieve this goal, an effective model is proposed that combines the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method (Fontela & Gabus, 1976), the Analytic Network Process (ANP) method (Saaty, 1996), and the modified VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje in Serbian, or Multicriteria Optimization and Compromise Solution) method (Opricovic, 1998) for evaluating and ranking national park websites. This model first applies the DEMATEL method to deal with the interdependence between evaluation criteria and convert the criteria's cause and effect relations into a visual structural map. Next, ANP is employed to determine the relative weights of evaluation criteria. The ANP, as a multiple criteria decision-making (MCDM) method, can be used to systematically deal with network-like decision problems. Finally, the VIKOR method is used to assess and rank the websites of seven national parks in Taiwan. The VIKOR method introduces an aggregating function, which then represents the site's distance from an ideal solution. This ranking index is an aggregation of all criteria, including the relative importance of criteria and a balance between total and individual satisfaction (Opricovic & Tzeng, 2004). One of its advantages is to take into account the lowest performance rating with respect to a specified criterion. Additionally, a weight-variance analysis (WVA), based on the concept of importance-performance analysis (IPA) (Martilla & James, 1977), is proposed to identify weakness areas most in need of urgent remedial action. The findings of this study can help National Park Headquarters form a clear picture of their websites' quality level. Furthermore, this study will be a valuable contribution for enhancing website design and for achieving desired quality levels. Hence, this combined four-phase method represents an effective tool for evaluating national park websites and for prioritizing improvement actions.

2. The concepts of website evaluation

2.1. The criteria of website evaluation

Website evaluation measures have been proposed in various contexts in recent years; researchers in this area struggle to determine important factors for evaluating online service and marketing. Zeithaml (2002) argued that electronic service quality (e-SQ) has seven dimensions that form two scales: 1) a core e-SQ scale that includes efficiency, fulfilment, reliability, and privacy; and 2) a recovery e-SQ scale that includes responsiveness, compensation, and contact. After a rigorous scale-development process was applied to the e-SQ, Parasuraman, Zeithaml, and Malhotra (2005) developed the E-S-QUAL as a measure of core service quality and the E-RecS-QUAL as a subscale for problem resolution. Subsequently, Kim, Kim, and Lennon (2006) proposed a modified E-S-QUAL model expected to capture extensive service attributes available on apparel retail websites. This model includes nine dimensions: the six dimensions from the original E-S-QUAL (efficiency, fulfilment, system availability, privacy, responsiveness, and contact) along with three additional dimensions (personalization, information, and graphic styles). Miranda-González and Bañegil-Palacios (2004) proposed a detailed Web Assessment Index, which focuses on four categories: accessibility, speed, navigability, and content. Cao, Zhang, and Seydel (2005) used factor analysis to capture the quality of three e-trade websites, which includes system quality, information quality, service quality, and attractiveness. Ho and Lee (2007) also used factor analysis to develop an e-travel service quality scale, which includes five core components: information quality, security, website functionality, customer relationships, and responsiveness. Barnes and Vidgen (2002) developed a scale to measure an organisation's e-commerce offering; the scale provides an index of a site's quality and includes five factors: usability, design, information, trust, and empathy.

Closely linked to the concept of website quality is the notion of usability. Usability has been defined and measured in many different ways (Agarwal & Venkatesh, 2002). Nielsen (1993) proposed that usability has five attributes: learnability, efficiency, memorability, low error rate or easy error recovery, and satisfaction. He also suggested that "usability is a quality attribute that assesses how easy user interfaces are to use" (Nielsen, 2003). The International Organisation for Standardization (ISO) defined usability as "the extent in which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO, 1998). Nielsen (2000) extended information system design principles for Web and suggested four parameters for usability: (1) navigation, (2) response time, (3) credibility, and (4) content. Agarwal and Venkatesh (2002) utilized the Microsoft Usability Guidelines to define website usability through five categories (content, ease of use, made-for-the-medium, promotion, and emotion), while Palmer (2002) defined usability based on five basis design elements extracted from usability and design as well as media richness literature (download delay, navigability, content, interactivity, and responsiveness). Au Yeung and Law (2006), Bai, Law, and Wen (2008) and Qi, Law, and Buhalis (2008) categorized usability into language usability, layout and graphics, information architecture usability, user interface and navigation, and general usability. Hassan and Li (2005) identified web usability as screen appearance consistency, accessibility, navigation, media use, interactivity, and content. Kim and Kim (2008) identified four usability criteria, which includes usefulness, effectiveness, satisfaction and supportiveness. On the other hand, Tarafdar and Zhang (2005) suggested that information content, ease of navigation, download delay, and website availability positively influence website usability. Pearson, Pearson, and

Green (2007) investigated the relative importance of five web usability criteria (navigation, customization and personalization, download speed, accessibility, and ease of use). They indicated "ease of use" is the most important criterion.

Based on a detailed review of previous literature, the relevant criteria for assessing national park websites are summarized as Table 1.

2.2. The methods of website evaluation

Many attempts have been made to address website evaluation for different organisational sectors and website categories. In particular, much literature focused on evaluation of travel-related websites (Baloglu & Pekcan, 2006; Doolin et al., 2002; Law, 2007; Lee & Kozar, 2006; Wan, 2002), hospital and government websites (Bilsel, Büyüközkan, & Ruan, 2006; Büyüközkan & Ruan, 2007), and education and e-learning websites (Büyüközkan, Ruan, & Feyzioğ̃lu, 2007; Kasli & Avcikurt, 2008; Shee & Wang, 2008).

Table 1
Website quality evaluation criteria.

Criterion	Definition
Navigability	This criterion measures how easy it is to navigate around the site, how easy it is to return to the home page of the site, how easy it is to find relevant information (Miranda-González & Bañegil-Palacios, 2004), how many links are required to get from one point in a site to another, and what search tools the site provides (Smith, 2001).
Speed	This criterion refers to quick connection and delivery, minimal use of large graphics and bright colours, easy access to links (Bilsel et al., 2006), and website loading speed (Smith, 2001).
Links	This criterion refers to availability of links to other government organisations (Büyüközkan & Ruan, 2007), different national parks, eco-protection, tourism and travel, and other related websites.
Relevancy	This criterion includes relevant depth and scope and completeness of information (Lee & Kozar, 2006). Different parts of the website should be designed to meet the needs of different group of visitors (Cao et al., 2005), such as travellers, researchers, students, and local citizens.
Richness	This criterion refers to detailed level and scope of information content. That is, formations contained on the website are rich in content (Bilsel et al., 2006).
Currency	This criterion refers to up-to-date information. Last update/review dates are a critical way of notifying users of the currency of content (Lee & Kozar, 2006; Smith, 2001).
Attractiveness	This criterion consists of whether web pages are fun to read and help visitor promote their excitement, such as through graphics, online games, cartoons, screensavers, software downloads, and Q&As (Cao et al., 2005; Huizingh, 2000; Miranda-González & Bañegil-Palacios, 2004).
Security	This criterion deals with how a website proves to be trustworthy for customers (Ho & Lee, 2007). A confident website should assure the secrecy of its users' personal and private data as well as prevent the content of a message from being tampered with (Büyüközkan et al., 2007; Chu, 2001).
Personalization	This criterion includes an individualized interface, effective one-to-one information, and customized service (Lee & Kozar, 2006). Customized content of the website can provide a user with the relevant and up-to-date information that will address his specific needs (Ho & Lee, 2007).
Responsiveness	This criterion deals with the provision of information on FAQs and prompts assistance for solving problems (Ahn, Ryu, & Han, 2007; Ho & Lee, 2007). Various service functions, such as complaint management systems (Lee & Kozar, 2006), should be provided.

There is no universally accepted method or technique for website evaluation. Various assessment techniques have been employed to evaluate websites using subjective approaches based on individual preferences, such as the Analytic Hierarchy Process (AHP) (e.g., Lee & Kozar, 2006; Shee & Wang, 2008), the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) (e.g., Büyüközkan & Ruan, 2007; Law, 2007), the Preference Ranking Organisation Method for Enrichment Evaluation (PROMETHEE) (e.g., Bilsel et al., 2006), and the VIKOR (e.g., Büyüközkan et al., 2007). Bilsel et al. (2006) used the AHP and Fuzzy PROMETHEE ranking methods to evaluate website quality for nine hospitals according to seven e-service quality dimensions (tangibles, reliability, responsiveness, confidence, empathy, quality of information, and integration of communication). Lee and Kozar (2006) applied AHP to evaluate four online electronics and four online travel websites by adopting DeLone and McLean's IS success model. AHP can only obtain relative weights for criteria and alternatives; it cannot compute gaps between the status quo and an ideal point of an alternative. Büyüközkan et al. (2007) used the Fuzzy VIKOR method to evaluate 21 e-learning websites according to seven criteria (right and understandable content, complete content, personalization, security, navigation, interactivity, and user interface). They neglected interrelationships between these seven criteria when determining their weights. Büyüközkan and Ruan (2007) used Fuzzy AHP and Fuzzy TOPSIS to rank 13 Turkish government websites according to six e-service quality dimensions. TOPSIS, however, has some limitations. According to Wang, Luo, and Hua (2007), TOPSIS' closeness coefficient values do not reflect the superiority or inferiority of alternatives and therefore cannot be used for ranking purposes.

Other methods include evaluating websites using content analysis. Cai, Card, and Cole (2004) and Baloglu and Pekcan (2006) utilized content analysis to analyze the websites of 20 US tour operators and 139 hotels, respectively, using a measurement variable of yes/no (1/0). Kasli and Avcikurt (2008) also used content analysis to examine the websites of 132 tourism departments at universities. The shortcoming of binary variables is that they cannot express the performance of each criterion (i.e., the quality of various features). In addition, Wan (2002) used content analysis to evaluate the websites of 30 tourist hotels and 39 tour wholesalers using a five-point rating scale. He took into account the performance on each criterion, but the relative importance of various criteria was neglected.

Table 2 summarizes the disadvantages of previous studies of website evaluation. As shown in Table 2, previous studies have failed to provide a comprehensive and systematic approach that quantitatively measures a website's overall performance, and their research methodologies must be improved. Therefore, this study proposes an effective evaluation model that combines DEMATEL, ANP, and a modified VIKOR to assess national park websites in terms of website quality. The proposed model overcomes the drawbacks of prior studies and offers enough insights for National Park Headquarters to accurately measure the current level of their websites according to critical criteria.

It is worth noting that usability evaluation techniques have been developed and incorporated into the design and development of websites. These techniques were used to evaluate interfaces for the purpose of identifying problems in order to improve usability of the interfaces (Ahmed, 2008). Several studies used usability techniques to evaluate websites' usability (e.g., Ahmed, 2008; Aitta, Kaleva, & Kortelainen, 2008). These studies involved a focus on the interface and discovered different kinds of usability problems; however, our proposed model used MCDM techniques to evaluate and rank various websites.

Table 2
Summary of the disadvantages of previous studies of website evaluation.

References	Methods	Evaluated websites	Disadvantages
Lee and Kozar (2006)	AHP	Online electronics and online travel websites	They used AHP to rank websites. AHP can only obtain relative weights for criteria and alternatives; it cannot compute gaps between the status quo and an ideal point for websites.
Bilsel et al. (2006)	AHP and Fuzzy PROMETHEE	Hospital websites	They used PROMETHEE II to rank websites. PROMETHEE II can only provide a complete pre-ordering through a comparison of net outranking flows; it cannot compute gaps between the status quo and an ideal point.
Büyüközkan et al. (2007)	Fuzzy VIKOR	E-learning websites	They ignored interrelationships between the seven criteria when determining their weights.
Büyüközkan and Ruan (2007)	Fuzzy AHP and Fuzzy TOPSIS	Government websites	They used TOPSIS to rank websites. TOPSIS' closeness coefficient values do not reflect the superiority or inferiority of alternatives and therefore cannot be used for ranking purposes (Wang et al., 2007).
Cai et al. (2004)	Content analysis	Tour operator websites	They used a measurement variable of yes/no (1/0). The shortcoming of binary variables is that they cannot express the performance of each criterion (i.e., the quality of various features).
Baloglu and Pekcan (2006)	Content analysis	Hotel websites	They used a measurement variable of yes/no (1/0). The shortcoming of binary variables is that they cannot express the performance of each criterion (i.e., the quality of various features).
Kasli and Avcikurt (2008)	Content analysis	University websites	They used a measurement variable of yes/no (1/0). The shortcoming of binary variables is that they cannot express the performance of each criterion (i.e., the quality of various features).
Wan (2002)	Content analysis	Tourist hotel and tour wholesaler websites	He took into account the performance on each criterion, but the relative importance of various criteria was ignored.

3. The four-phase method for website evaluation

To effectively evaluate national park websites and suggest improvement actions, a combined four-phase method is proposed. This combined four-phase method is a novel hybrid method which integrated DEMATEL, ANP, the modified VIKOR, and WVA. Previous studies have applied the integrated AHP-VIKOR method to solve different problems such as restaurant location selection (Tzeng, Teng, Chen, & Opricovic, 2002), environmental management (Tzeng, Tsaur, Laiw, & Opricovic, 2002), and public transportation (Tzeng, Lin, & Opricovic, 2005). AHP is based on the additive concept along with the independence assumption, but each individual criterion is not always completely independent in reality (Wu & Lee, 2007). Therefore, instead of adopting AHP, we combined DEMATEL method and ANP method to treat interdependence between criteria. The weights obtained through ANP were combined with the modified VIKOR method to compute the comprehensive performance variance rate of each website. VIKOR can only obtain the ranking of websites; it cannot identify weakness areas most in need of urgent remedial action. Therefore, we applied WVA to suggest improvement actions.

The evaluation process includes four phases: (1) applying the DEMATEL method; (2) applying the ANP method; (3) applying the modified VIKOR method; and (4) employing the WVA method. Accordingly, an overview of the evaluation process for national park websites is shown in Fig. 1. The details of each phase are described below.

First, we apply the DEMATEL method prior to the ANP procedure in order to improve the procedure for dealing with the interrelationships between criteria. Previous ANP studies (e.g., Lee & Kim, 2000; Lin, Tsai, Shiang, Kuo, & Tsai, 2009; Wey & Wu, 2007) coped with interdependence of criteria through group discussion and did not quantify the strength of interdependence between criteria. Therefore, DEMATEL method is used to quantify complex relationships between criteria and to convert these relationships into an influence-relation-map (IRM) (Tsai & Chou, 2009; Tsai, Chou, & Hsu, 2009).

Second, we apply the ANP method to build the network structure for evaluating websites by using the IRM, and then to calculate the weights for each criterion. The ANP method is a comprehensive decision-making technique that has the capability of dealing with complex interrelationships between attributes and decision levels, while the AHP model's decision-making structure uses straightforward hierarchical relationships among decision levels (Chang, Wu, Lin, & Lin, 2007; Tuzkaya, Önüt, Tuzkaya, & Gülsün, 2008). Therefore, instead of adopting the commonly used AHP method for solving these types of problems, we used an ANP-based model for calculating the weights for each criterion.

Then, we modify the traditional VIKOR method regarding the measure of closeness to an ideal alternative. The modified VIKOR offers more rational formulas for computing the gaps between the status quo and the ideal point for websites (i.e., unimproved gaps).

Finally, we employ WVA to identify those criteria of website quality that are most in need of urgent remedial action. WVA offers an understandable guide to assist National Park Headquarters in organising limited resources toward improvement actions.

The combined four-phase method not only can adequately cope with the interdependence between criteria but also can suggest improvement actions to reduce the gaps between the status quo and the ideal point for websites. The following describes in more detail the four methods used in this study.

3.1. The DEMATEL method

The DEMATEL method was devised for a Science and Human Affairs Program by the Battelle Memorial Institute of Geneva

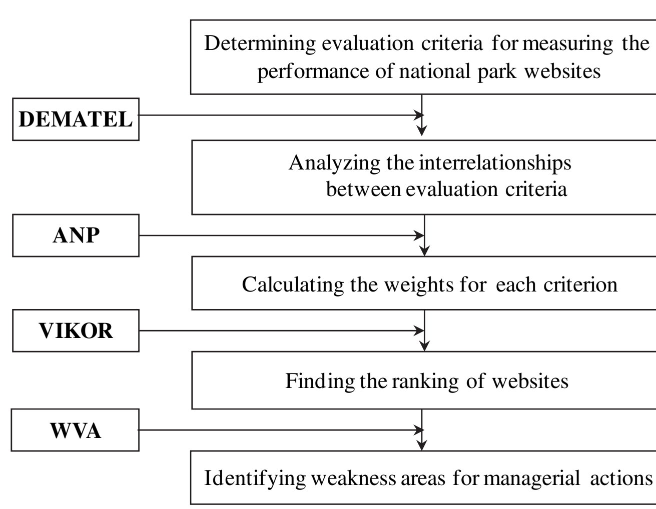

Fig. 1. The evaluation process for national park websites.

between 1972 and 1976. DEMATEL converts the mutual relationships between criteria's causes and effects into an intelligible structural model for the system (Tzeng, Chiang, & Li, 2007). It has been successfully applied in a wide range of situations, such as R&D projects (Lin & Wu, 2008), e-learning evaluations (Tzeng et al., 2007), airline safety measurements (Liou, Tzeng, & Chang, 2007), social responsibility programs (Tsai & Hsu, 2008; Tsai, Hsu, Chen, Lin, & Chen, 2009), socially responsible investments (Tsai, Chou, et al., 2009), sustainable management (Tsai & Chou, 2009), and IT projects sourcing strategy mix decision (Tsai, Leu, Liu, Lin, & Shaw, 2010). This method progresses as follows:

Step 1: Producing the initial direct-relation matrix. The evaluators who are selected in terms of professional knowledge and skill are asked to indicate the degree of direct influence of each criterion over others. To ensure objectivity, there are at least three evaluators to execute the evaluation (Van der Merwe & Bekker, 2003). The pair-wise comparison scale can be broken down into five levels including "no influence (0)," "low influence (1)," "medium influence (2)," "high influence (3)," and "very high influence (4)" (Chiu, Chen, Tzeng, & Shyu, 2006; Liou et al., 2007). The result of this comparison produces an initial direct-relation matrix. The initial direct-relation matrix $\boldsymbol{B}$ is an $n \times n$ matrix, where b_{ij} is denoted as the degree to which the ith criterion affects the jth criterion. It is represented by Eq. (1). Accordingly, all principal diagonal elements b_{ij} of matrix $\boldsymbol{B}$ are set to be zero. Assume each time only changes a parameter in matrix $\boldsymbol{B}$. There are $5 \times [n(n-1)]$ possible mixes. Excel software can be applied to aid in the calculations of sensitivity analyses. For example, when b_{ij} are changed from 2 (medium influence) to 3 (high influence), the number of elements whose influence levels in the total-relation matrix are greater the threshold value will increase. In other words, each time the value of a parameter increases, some new interrelationships will be added to the IRM.

$$\boldsymbol{B} = \begin{bmatrix} b_{11} & \cdots & b_{1j} & \cdots & b_{1n} \\ \vdots & & \vdots & & \vdots \\ b_{i1} & \cdots & b_{ij} & \cdots & b_{in} \\ \vdots & & \vdots & & \vdots \\ b_{n1} & \cdots & b_{nj} & \cdots & b_{nn} \end{bmatrix} \tag{1}$$

Step 2: Calculating the normalized direct-relation matrix. The normalized direct-relation matrix can be obtained through formulas (2)–(4), where all principal diagonal elements are equal to zero (Chiu et al., 2006).

$$\boldsymbol{X} = \boldsymbol{B}/r \tag{2}$$

$$r = \mathrm{Max}\left(\max_{1 \le i \le n} \sum_{j=1}^{n} |b_{ij}|, \max_{1 \le j \le n} \sum_{i=1}^{n} |b_{ij}| \right), \quad i,j \in \{1,2,3,\ldots,n\} \tag{3}$$

$$\lim_{i \to \infty} \boldsymbol{X}^i = [0]_{n \times n}, \quad \text{where} \quad \boldsymbol{X} = [x_{ij}]_{n \times n}, \quad 0 \le x_{ij} < 1 \tag{4}$$

Step 3: Computing the total-relation matrix. Once the normalized direct-relation matrix $\boldsymbol{X}$ has been obtained, a continuous decrease in problems' indirect effects along the powers of the matrix $\boldsymbol{X}$, e.g., $\boldsymbol{X}^2$, $\boldsymbol{X}^3$,..., $\boldsymbol{X}^\infty$, guarantees convergent solutions to the matrix inversion. The total-relation matrix $\boldsymbol{T}$ can be derived by using formula (5), where $\boldsymbol{I}$ is denoted as the identity matrix (Chiu et al., 2006; Liou et al., 2007).

$$\boldsymbol{T} = \boldsymbol{X} + \boldsymbol{X}^2 + \boldsymbol{X}^3 + \ldots = \sum_{i=1}^{\infty} \boldsymbol{X}^i = \boldsymbol{X}(\boldsymbol{I} - \boldsymbol{X})^{-1} \tag{5}$$

Step 4: Computing the values of influence and relation. Using the values of $\boldsymbol{D} - \boldsymbol{R}$ and $\boldsymbol{D} + \boldsymbol{R}$, where $\boldsymbol{D}$ is the sum of columns and $\boldsymbol{R}$ is the sum of rows in matrix $\boldsymbol{T}$, levels of influence on others and levels of relationships with others are defined as shown in formulas (6)–(8) (Hori & Shimizu, 1999; Wu & Lee, 2007). Some criteria having positive values of $\boldsymbol{D} - \boldsymbol{R}$ and thus greatly influence other criteria. These criteria are called dispatchers; others having negative values of $\boldsymbol{D} - \boldsymbol{R}$ and thus are greatly influenced by other criteria. These are called receivers. The value of $\boldsymbol{D} + \boldsymbol{R}$ indicates the degree of relationship between each criterion with other criteria. Criteria having higher values of $\boldsymbol{D} + \boldsymbol{R}$ have stronger relationships with other criteria, while those having lower values of $\boldsymbol{D} + \boldsymbol{R}$ have less of a relationship with others (Seyed-Hosseini, Safaei, & Asgharpour, 2006).

$$\boldsymbol{T} = [t_{ij}]_{n \times n} \quad i,j \in \{1,2,3,\ldots,n\} \tag{6}$$

$$\boldsymbol{D} = \left[\sum_{j=1}^{n} t_{ij} \right]_{n \times 1} = [t_{i\cdot}]_{n \times 1} \tag{7}$$

$$\boldsymbol{R} = \left[\sum_{i=1}^{n} t_{ij} \right]_{1 \times n}^{t} = [t_{\cdot j}]_{n \times 1} \tag{8}$$

where superscript t denotes transposition.

Step 5: Setting a threshold value to obtain the IRM. If all the information from matrix $\boldsymbol{T}$ converts to the IRM, the map will be too complex to show necessary information for decision-making. To obtain an appropriate IRM, the decision-maker must set a threshold value for the influence level. Only some elements, whose influence levels in matrix $\boldsymbol{T}$ are greater than the threshold value, can be chosen and converted into the IRM. The threshold value is decided by experts or decision-makers through discussions (Tzeng et al., 2007). If the threshold value is too low, the map will be too complex to show the necessary information for decision-making. In contrast, if the threshold value is too high, many factors will be presented as independent factors, without showing the relationships with other factors. Each time the threshold value increases, some relationships will be removed from the map (Tzeng et al., 2007). An example based on a total-relation matrix $\boldsymbol{T}^{\mathrm{ex}}$ is shown as formula (9) and in Fig. 2. An appropriate threshold value is necessary to obtain a suitable IRM as well as adequate information for further analysis and decision-making (Li & Tzeng, 2009). Finally, the IRM is acquired by mapping the dataset ($\boldsymbol{D}+\boldsymbol{R}, \boldsymbol{D}-\boldsymbol{R}$), where the horizontal axis is $\boldsymbol{D}+\boldsymbol{R}$, and the vertical axis is $\boldsymbol{D}-\boldsymbol{R}$ (Wu & Lee, 2007)

$$\boldsymbol{T}^{\mathrm{ex}} = \begin{array}{c} \\ G1 \\ G2 \\ G3 \\ G4 \end{array} \begin{array}{c} \begin{array}{cccc} G1 & G2 & G3 & G4 \end{array} \\ \begin{pmatrix} 1.108 & 1.501 & 1.575 & 1.712 \\ 1.317 & 1.188 & 1.609 & 1.695 \\ 1.042 & 1.123 & 1.056 & 1.472 \\ 0.893 & 0.962 & 1.048 & 0.976 \end{pmatrix} \end{array} \quad (9)$$

The positive significant value of $\boldsymbol{D}-\boldsymbol{R}$ represents that the criterion affects other criteria much more than the other criteria affected it, implying it should be a priority for improvement. In managerial implications, the results of the DEMATEL can provide some insights for organisations to improve their performance based on the most powerful criterion that greatly influences the performance of other criteria (Tsai, Chou, et al., 2009). Therefore, the supplemental value of getting the information regarding interdependency exceeds the added complexity of applying DEMATEL. It is suitable to apply DEMATEL prior to the ANP procedure.

3.2. The ANP method

The ANP, developed by Thomas L. Saaty, provides a means to input judgments. The ANP also provides measurements to derive ratio scale priorities for the distribution of influence between factors and groups of factors in the decision (Saaty, 2003). ANP has been successfully applied to many practical decision-making problems, such as ERP software selection (Ayağ & Özdemİr, 2007), logistics service provider selection (Jharkharia & Shankar, 2007), digital video recorder systems evaluation (Chang et al., 2007), undesirable facilities location selection (Tuzkaya et al., 2008), and social responsibility programs (Tsai & Hsu, 2008; Tsai, Hsu, Chen, et al., 2009). According to Saaty (2001), the ANP comprises six main steps:

Step 1: Conducting pair-wise comparisons on the elements using Saaty's nine-point scale (Saaty, 2001). The scale ranges from equal importance (one) to extreme importance (nine).

Step 2: Computing relative importance weights (eigenvectors) for each element and testing the consistency ratio (CR). If the CR is greater than 0.1, the result is not consistent, and the pair-wise comparison is performed again.

Step 3: Placing the results of these computations within the supermatrix (unweighted). The supermatrix concept resembles a Markov chain process. To obtain global priorities in a system with interdependent influences, the local priority vectors are added to the appropriate columns of a matrix, which is known as a supermatrix.

Step 4: Conducting pair-wise comparisons on the clusters.

Step 5: Weighting the blocks of the unweighted supermatrix by the corresponding cluster priorities, such that the result is column-stochastic (weighted supermatrix).

Step 6: Raising the weighted supermatrix to limiting powers until the weights converge and remain stable (limit supermatrix).

3.3. The modified VIKOR method

VIKOR has been introduced as an applicable technique for implementation within MCDM (Opricovic, 1998; Opricovic & Tzeng, 2002, 2003, 2004; Tsai, Hsu, & Lin, 2009; Tzeng et al., 2005; Tzeng, Teng, et al., 2002; Tzeng, Tsaur, et al., 2002); VIKOR focuses on ranking and selecting (from a set of alternatives) in the presence of conflicting criteria (Opricovic & Tzeng, 2007). This method considers two distance measurements, S_j and Q_j, based on an aggregating function ($L_p - metric$) in the compromising programming method in order to provide information about utility and regret; the best alternative has the maximum group utility for decision-makers and ensures the least regret (Opricovic & Tzeng, 2004, 2007). Thus, the VIKOR method can provide measurements of determining the aggregate relative distance between the perceptive performances and the ideal performances of alternatives (Tsai, Hsu, & Lin, 2009). The VIKOR method includes the following steps:

Step 1: Determining the maximum f_i^* and the minimum f_i^- values of all criterion functions, $i = 1, 2,\ldots, n$. If the criterion i represents a benefit, then $f_i^* = \max_j f_{ij}, f_i^- = \min_j f_{ij}$. Naturally, a candidate having scores $(f_1^*, f_2^*, \ldots, f_n^*)$ would be a positive-ideal candidate, whereas a candidate having scores $(f_1^-, f_2^-, \ldots, f_n^-)$ would be a negative-ideal candidate.

Step 2: Computing the values of S_j and Q_j. These values represent group utility and individual regret for the alternative a_j, respectively, with the relations

$$S_j = L_j^{p=1} = \sum_{i=1}^{n} w_i \left[\left(f_i^* - f_{ij} \right) / \left(f_i^* - f_i^- \right) \right], \text{ for } j = 1, \ldots, m \quad (10)$$

$$Q_j = L_j^{p=\infty} = \max_i \left\{ w_i \left[\left(f_i^* - f_{ij} \right) / \left(f_i^* - f_i^- \right) \right] \middle| i = 1, 2, \ldots, n \right\}, \quad \text{for} \quad j = 1, \ldots, m \quad (11)$$

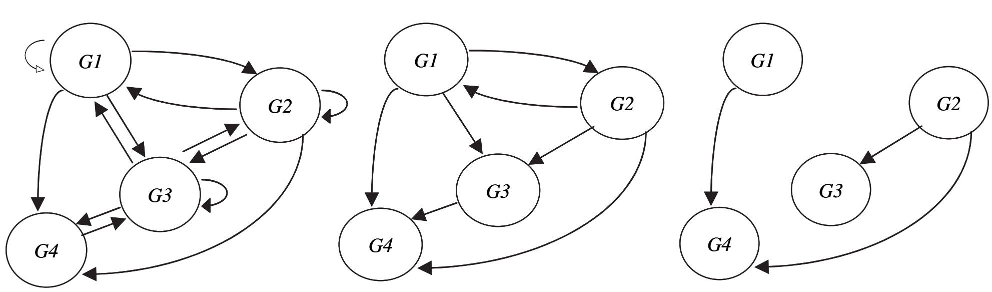

Fig. 2. Influence-relation-maps based on the different threshold values.

where the weights of the criteria (w_i) are introduced in order to express the relative importance of criteria as computed by the ANP method.

Step 3: Computing the aggregate value (R_j). Its formula is:

$$R_j = v\left[\left(S_j - S^*\right)/\left(S^- - S^*\right)\right] + (1-v)\left[\left(Q_j - Q^*\right)/\left(Q^- - Q^*\right)\right], \text{for } j = 1,\ldots,m \quad (12)$$

where $S^* = \min_j S_j, S^- = \max_j S_j, Q^* = \min_j Q_j$, and $Q^- = \max_j Q_j$; v is introduced as a weight for the strategy of maximizing group utility, whereas $1-v$ is the weight of the individual regret.

Step 4: Ranking alternatives by sorting each S_j, Q_j, and R_j values in an increasing order. The result is a set of three ranking lists denoted by $S(\cdot)$, $Q(\cdot)$ and $R(\cdot)$.

Step 5: Proposing the alternative a', which is first ranked by the measure $\min\{R_j | j = 1, 2, \ldots, m\}$ as a single optimal solution. The alternative must satisfy two conditions as follows:

N1. The alternative a' has an acceptable advantage; in other words, $R(a'') - R(a') \geq h$ where $h = 1/(m-1)$ and m is the number of alternatives ($h = 0.25$ if $m \leq 4$).

N2. The alternative a' is stable within the decision-making process; in other words, it is also the best ranked in $S(\cdot)$ or/and $Q(\cdot)$.

If one of the above conditions is not satisfied, then a set of compromise solutions is proposed, which consists of:

- Alternatives a' and a'', if only the condition **N2** is not satisfied, or
- Alternatives $a', a'', \ldots, a^{(k)}$, if the condition **N1** is not satisfied; and $a^{(k)}$ is determined by the relation $R(a^{(k)}) - R(a') \approx h$ (the positions of these alternatives are "in closeness").

In the traditional VIKOR method, the values of S^*, S^-, Q^*, and Q^- come from the candidate alternatives; there are not real positive-ideal values or negative-ideal values for all criteria. Therefore, following Ou Yang, Shieh, Leu, and Tzeng (2009), the positive-ideal value S^* would be zero; the negative-ideal value S^- would be equal to one; the positive-ideal value Q^* would be zero, and the negative-ideal value Q^- would be equal to one. In addition, Eq. (13) is used instead of the traditional Q_j (i.e., the weights (w_i) were removed from Eq. (11)). The modified Q_j^{mod} and R_j^{mod} index are listed as follows:

$$Q_j^{\text{mod}} = \max_i \left[\left(f_i^* - f_{ij}\right)/\left(f_i^* - f_i^-\right) \middle| i = 1, 2, \ldots, n\right], \text{for } j = 1, \ldots, m \quad (13)$$

$$R_j^{\text{mod}} = vS_j + (1-v)Q_j^{\text{mod}} \quad (14)$$

It is important to note that the value of h should be changed to $h^{\text{mod}} = (\max_j R_j^{\text{mod}} - \min_j R_j^{\text{mod}})/(m-1)$ in the modified VIKOR method. Other conditions are the same as those with the traditional VIKOR method.

3.4. The weight-variance analysis

As mentioned above, the ranking index of the modified VIKOR method represents a compound measurement of S_j and Q_j^{mod}. The S_j value is comprised of the ANP weight (w_i) of the ith criterion and the performance variance rate ($(f_i^* - f_{ij})/(f_i^* - f_i^-)$) of the ith criterion of the jth alternative. The Q_j^{mod} value represents the jth alternative with respect to the ith criterion calculated by the highest performance variance rate. To describe the components of S_j and Q_j^{mod} in detail, the WVA (which is based on the IPA concept of Martilla & James, 1977) is proposed, except that the "performance variance rate" replaces the "performance" component and the "ANP weight" is substituted for the "importance" component. WVA provides a more fine-grained analysis focusing on the gaps between an actual website and an ideal website according to particular evaluation criteria. The performance variance rate is then plotted against the ANP weight to provide a graphic representation of which evaluation criteria are most in need of improvement. The "ANP weight" constitutes the vertical axis (y-axis) and "performance variance rate" constitutes the horizontal axis (x-axis) of a coordinate diagram, which is labelled the weight-variance map (WVM). We then follow Abalo, Varela, and Manzano (2007) in using a partition that combined four quadrant and diagonal-based schemes for the WVM, enlarging the top right quadrant so that the new region occupied the whole of the zone above the iso-rating line. Evaluation criteria located above the iso-rating line are a higher priority for improvement (Chang & Yang, 2008). Finally, the map is divided into four zones, as shown in Fig. 3. The following are recommendations for each of the four zones:

(1) Concentrate here (Zone 1): Evaluation criteria in this zone are perceived to be important for evaluators; however, the performance variance rate is high in this zone. Criteria falling in this zone constitute the top priority for remedial action, and the necessity of improvement is proportional to the horizontal distance from the iso-rating line (Chang & Yang, 2008).

(2) Keep up the good work (Zone 2): This zone indicates not only those criteria deemed important to evaluators, but also a low performance variance rate. Criteria in this zone require careful monitoring to ensure that low variance rate levels are maintained.

(3) Redeploy resources (Zone 3): This zone contains criteria of low importance, and the performance variance rate is also relatively low. Managers should not be overly concerned

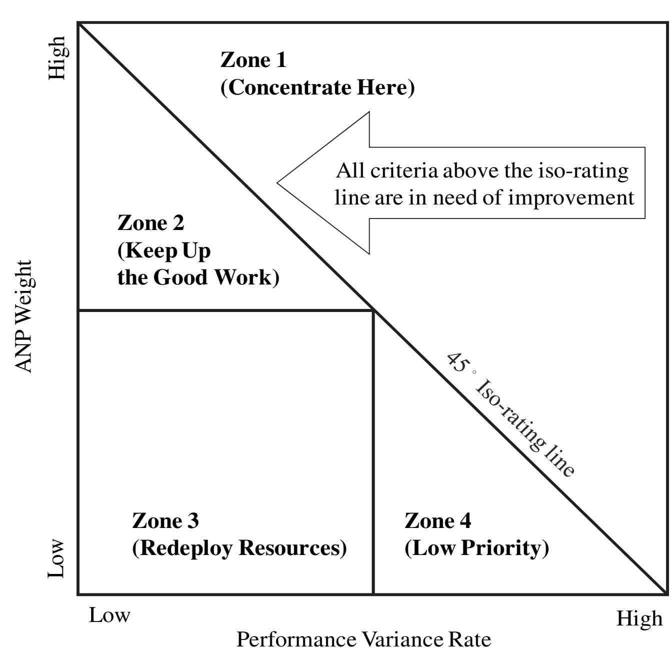

Fig. 3. The weight-variance map.

Table 3
Comparison of the DEMATEL, ANP, modified VIKOR and WVA methods.

Methods	Advantages	Disadvantages
DEMATEL	It is an effective tool for analyzing structure and relationships between components of a system (Tzeng et al., 2007).	It is time-consuming to choose a consistent threshold value, especially if there are too many experts' opinions to aggregate at the same time (Li & Tzeng, 2009).
ANP	It allows for more complex relationship among the decision levels and attributes as it does not require a strict hierarchical structure (Ravi, Shankar, & Tiwari, 2005).	The pair-wise comparison of criteria under consideration can only be subjectively performed, and their accuracy of the results depends on the evaluator's expertise knowledge in the area concerned (Ravi et al., 2005).
Modified VIKOR	It determines a compromise solution that could be accepted by the decision-makers because it provides a maximum group utility for the "majority", and a minimum of individual regret for the "opponent" (Tzeng, Teng, et al., 2002; Tzeng, Tsaur, et al., 2002; Tzeng et al., 2005).	It uses a fixed common numbers of criteria for all projects. However, it cannot aggregate the unimproved gaps according to the particular criteria for each project/aspect (Ou Yang et al., 2009).
WVA (Modified IPA)	It is a relatively quick and inexpensive method for identifying areas in need of improvement by using a simple and visible map (Skok et al., 2001).	It clearly sacrifices depth and is unlikely to provide the detailed insights found from in-depth interviews (Skok et al., 2001).

about criteria in Zone 3; consideration should be given to the possibility of redeploying resources to remedial action in Zone 1.

(4) Low priority (Zone 4): Evaluation criteria in Zone 4 are rated as having low importance and a high performance variance rate. It is therefore not necessary to focus additional effort or resources to criteria in this zone.

The IPA method, a facile and visible analysis, reveals strengths and weaknesses of attributes for identifying areas in need of improvement (Chen & Chang, 2005; Skok, Kophamel, & Richardson, 2001). This study modified the original IPA and transformed the components of the VIKOR index into the WVA. This modification provides a powerful tool for guiding the prioritization of improvement actions.

In sum, the similarity of these four methods is that the data come from subjective judgments of evaluators; the difference of them is that each method has its own capability for solving a specific problem. First, the DEMATEL method not only can deal with interrelationships of criteria but also can integrate them into a visible structural map. Second, the ANP method not only can build the network structure by using the IRM but also can calculate the weights for each criterion. Next, the weights obtained through ANP are combined with the modified VIKOR method to compute performance variance rates between the status quo and the ideal point for websites. Finally, WVA can integrate ANP weights and performance variance rates into a two-axis map and suggest improvement actions. However, these four methods have their own advantages and disadvantages, as shown in Table 3.

4. Evaluation of the national park websites

To describe the proposed model clearly, a case study of national park websites was conducted in order to demonstrate the efficacy of this model for assessing website quality. The research objects in this study were all national park websites in Taiwan. There are seven national parks in Taiwan: Kenting, Yushan, Yangmingshan, Taroko, Shei-pa, Kinmen, and Dongsha Marine. Their websites are indicated as A_1, A_2, A_3, A_4, A_5, A_6, and A_7, respectively. We invited 16 experts to express their opinions in November 2008. Nine of them were from various industries and the remaining ones were from academics and research institutes. These experts are professionals who have been designing websites or studying on various projects about e-government and e-business for a certain time; therefore,

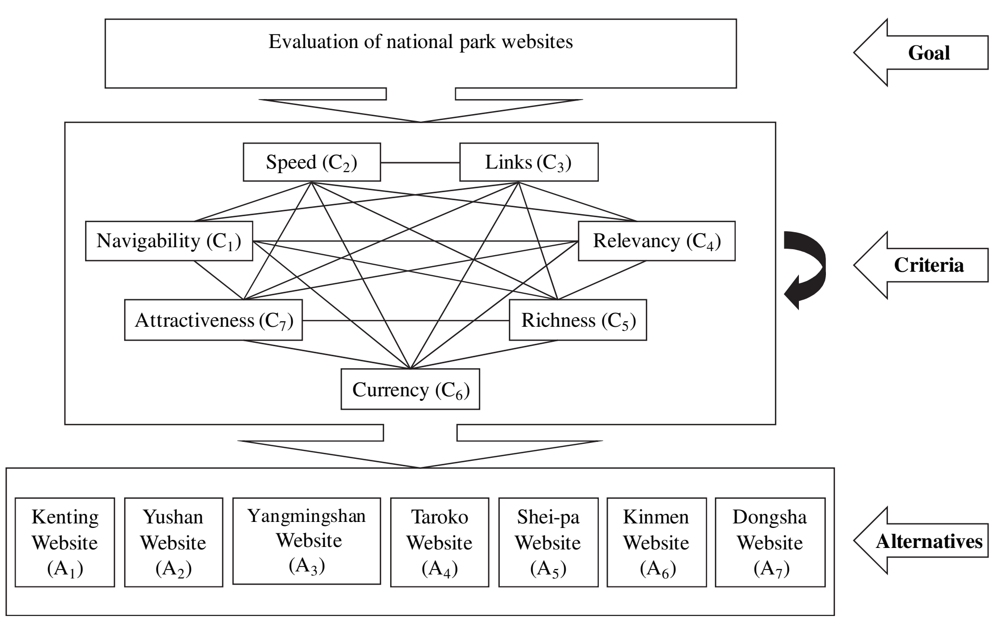

Fig. 4. A standard network for the case study.

Table 4
The initial direct-relation matrix.

	Navigability (C_1)	Speed (C_2)	Links (C_3)	Relevancy (C_4)	Richness (C_5)	Currency (C_6)	Attractiveness (C_7)
Navigability (C_1)	0.000	2.063	1.688	2.063	2.375	2.063	2.875
Speed (C_2)	3.188	0.000	1.750	1.563	1.813	2.000	2.938
Links (C_3)	2.375	2.000	0.000	2.500	2.938	1.938	2.563
Relevancy (C_4)	2.625	1.750	1.688	0.000	2.813	2.250	2.813
Richness (C_5)	2.813	2.625	1.625	2.313	0.000	1.875	3.000
Currency (C_6)	2.688	2.250	2.250	2.688	2.563	0.000	3.188
Attractiveness (C_7)	2.563	2.188	1.688	1.875	2.125	1.938	0.000

their answers to questionnaires can appropriately reflect the status quo of each national park website.

4.1. Calculation of the weights of evaluation criteria

First, the experts indicated that the presence of too many criteria would make the website evaluation process difficult and complex. As mentioned in Section 2, ten relevant criteria were identified as key factors for website quality. To ensure that these potential criteria were valid measures for evaluating national park websites, the experts examined the status quo of seven websites beforehand and then used the cut-off value method with the nine-point scale to screen for proper criteria. Based on the survey results of these important criteria, seven criteria were constructed as very important to the success of the websites, with a mean value exceeding 6.0 (i.e., cut-off value) for each criterion. The seven criteria were noted as navigability (C_1), speed (C_2), links (C_3), relevancy (C_4), richness (C_5), currency (C_6), and attractiveness (C_7). The remaining three criteria (i.e., security, personalization, responsiveness) were excluded because they were considered to be relatively unimportant for the evaluation of national park websites (with mean scores of 3.1, 2.5, and 4.2, respectively).

In the recent years, the issue of accessibility has become a concern for many countries, including the Taiwanese government. The Executive Yuan (i.e., the highest administrative agency in Taiwan) has established the Accessible Web Development Guidelines (AWDG) based on the Web Content Accessibility Guideline 1.0 of Web Accessibility Initiative from World Wide Web Consortium (RDEC, 2008). The seven national park websites have obtained "web accessibility conformance seals" from the Executive Yuan and they continuously comply with AWDG. Therefore, accessibility was not included in the proposed model, as this criterion performed well in all seven websites. In addition, the "Alternatives" cluster consisted of seven national park websites. Fig. 4 shows the standard network for this case study.

Second, in order to determine the relationship structure among the seven evaluation criteria, a zero–four DEMATEL scale was used for assessment purposes. This scale was designated as five levels: the score of 0 (No influence), 1 (Low influence), 2 (Medium influence), 3 (High influence), and 4 (Very high influence), respectively. It can help experts apply the pair-wise comparisons to model a mathematical relationship between criteria. Once the relationships between criteria had been measured by the experts, the initial direct-relation matrix could then be obtained (Table 4). Based on an initial direct-relation matrix, a normalized direct-relation matrix was obtained using the DEMATEL formula. Next, the total-relation matrix (including $\boldsymbol{D}$, $\boldsymbol{R}$, $\boldsymbol{D}+\boldsymbol{R}$ and $\boldsymbol{D}-\boldsymbol{R}$) was identified (Table 5). After deciding on a threshold value ($p = 0.500$) based on discussions with the evaluators, the relationships between criteria were identified by mapping the $\boldsymbol{D}+\boldsymbol{R}$ and $\boldsymbol{D}-\boldsymbol{R}$ dataset (Fig. 5). As shown in Fig. 5, evaluation criteria were visually divided into a dispatcher group, which included speed (C_2), links (C_3), relevancy (C_4), and currency (C_6), while the receiver group included navigability (C_1), richness (C_5), and attractiveness (C_7). The link (C_3), with the highest value of $\boldsymbol{D}-\boldsymbol{R}$, was called the master dispatcher. A good national park website provides all necessary Web links covering tourist spots, visitors' services, transportation, accommodation, and ecological conservation information; therefore, links (C_3) affected each of the other six criteria: navigability (C_1), speed (C_2), relevancy (C_4), richness (C_5), currency (C_6), and attractiveness (C_7). The IRM also indicated that links (C_3) and currency (C_6) strongly influenced other criteria for improving website quality. In contrast, attractiveness (C_7), with the lowest value of $\boldsymbol{D}-\boldsymbol{R}$, was the master receiver and was affected by each of the other six criteria. These results support Cao et al. (2005), who suggest that an attractive website begins with good content. Moreover, attractiveness (C_7), with the highest value of $\boldsymbol{D}+\mathbf{R}$, had the most relationships with other criteria. Finally, the results of the IRM informed the ANP in building the network relationship structure.

Phase 2 applied the ANP method to calculate a weight for each criterion. The experts responded to the questionnaire through a series of pair-wise comparisons with Saaty's one-nine scale, comparing the relative importance of one element over another. After computing the results of experts' assessments, the consistency ratio values were less than the acceptable threshold value (i.e., CR < 0.1) and the displayed eigenvectors were appropriate to enter into the supermatrix $\boldsymbol{M}$ (Table 6). The supermatrix did not need to be weighted since every column summed to one and the limit supermatrix could be computed directly. Finally, the supermatrix was raised to limiting powers of $\boldsymbol{M}^{\boldsymbol{L}}$ to capture all interactions and obtain

Table 5
The total-relation matrix.

	Navigability (C_1)	Speed (C_2)	Links (C_3)	Relevancy (C_4)	Richness (C_5)	Currency (C_6)	Attractiveness (C_7)	$\boldsymbol{D}$	$\boldsymbol{D}+\boldsymbol{R}$	$\boldsymbol{D}-\boldsymbol{R}$
Navigability (C_1)	0.490	**0.507**	0.424	**0.505**	**0.562**	0.483	**0.662**	3.633	8.040	−0.774
Speed (C_2)	**0.649**	0.403	0.429	0.483	**0.538**	0.481	**0.667**	3.650	7.251	0.049
Links (C_3)	**0.651**	**0.538**	0.363	**0.558**	**0.625**	**0.508**	**0.691**	3.934	6.952	0.916
Relevancy (C_4)	**0.649**	**0.516**	0.443	0.422	**0.608**	**0.512**	**0.689**	3.839	7.426	0.252
Richness (C_5)	**0.666**	**0.561**	0.445	**0.543**	0.473	**0.501**	**0.705**	3.894	7.875	−0.087
Currency (C_6)	**0.707**	**0.583**	**0.506**	**0.600**	**0.646**	0.440	**0.763**	4.245	7.628	0.862
Attractiveness (C_7)	**0.595**	0.493	0.408	0.476	**0.529**	0.458	0.495	3.454	8.126	−1.218
$\boldsymbol{R}$	4.407	3.601	3.018	3.587	3.981	3.383	4.672			

Note: The bold values represent values higher than the threshold value ($p = 0.500$).

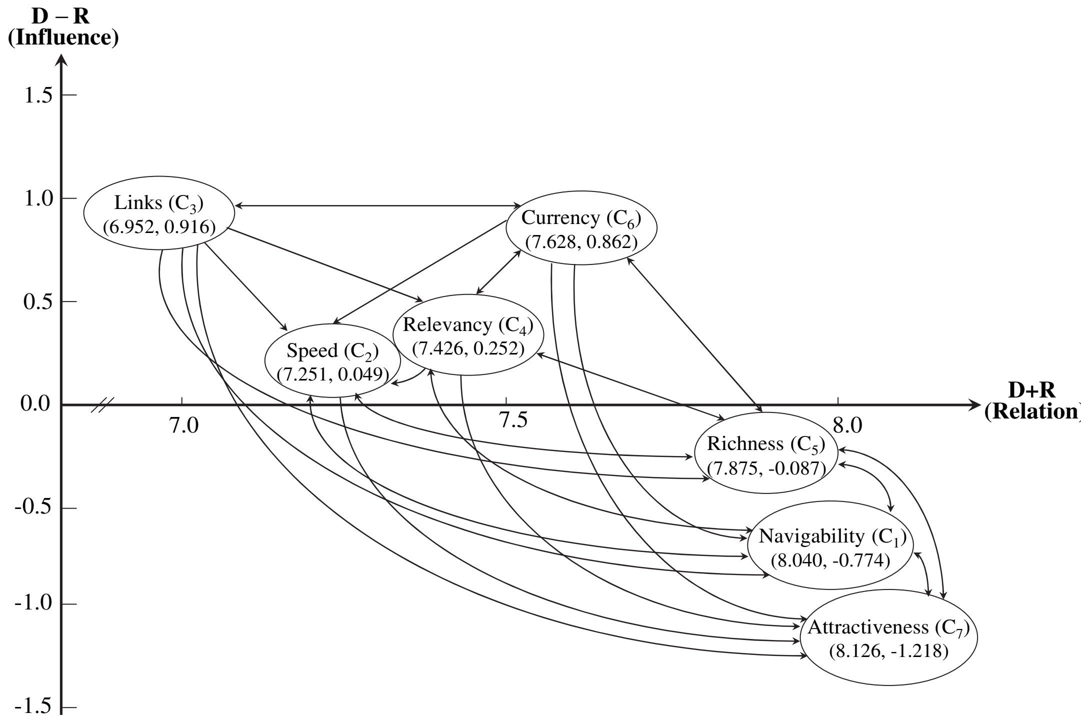

Fig. 5. The influence-relation-map of total relation.

a steady-state outcome. The limit supermatrix is shown in Table 7. The results of the limit supermatrix yielded (C_1, C_2, C_3, C_4, C_5, C_6, C_7) = (0.221, 0.113, 0.010, 0.125, 0.255, 0.080, 0.196). Ranked by the weights, the top-three evaluation criteria were richness (C_5), navigability (C_1), and attractiveness (C_7). These three criteria were influenced by the other criteria since the value of $\boldsymbol{D} - \boldsymbol{R}$ is negative according to the computation of the DEMATEL. The results of the ANP showed that the receiver group in the DEMATEL analysis obtained higher weights. If the interrelated structure of criteria were neglected, the results of the AHP would yield (C_1, C_2, C_3, C_4, C_5, C_6, C_7) = (0.146, 0.115, 0.077, 0.156, 0.179, 0.154, 0.173). Table 8 presents the relative weights for the seven criteria based on the results of the ANP, as well as the relative weights as determined by the AHP. It is interesting to contrast these two methods, as their results are significantly different in terms of derived weights and the ranking order of various criteria. The contrasting outcomes indicate that interdependencies between criteria can affect real decision-making processes. The ANP has a powerful capacity to solve more complex decision problems and deliver more reliable results than does the AHP (Ayağ & Özdemİr, 2007; Chang et al., 2007). Consequently, adopting a suitable method is important, as it influences the accuracy of the evaluation results. In addition, our study solved the problem of the study of Wan (2002), which only used a five-point rating scale to assess websites but neglected the relative importance for each criterion.

4.2. Performance measurement of the websites

After finishing a series of pair-wise comparisons, the evaluators were asked to provide linguistic values for the seven criteria. In this study, linguistic values were used to design the evaluation questionnaire. These performance values, which were very good, good, median, poor, and very poor, were transformed by scaling them into the numbers 100, 75, 50, 25, 0, respectively. Our study took into account the performance on each criterion and solved the problems of the studies of Baloglu and Pekcan (2006), Cai et al. (2004) and Kasli and Avcikurt (2008), which only used a measurement variable of yes/no.

The average assessed value, f_{ij}, for the jth alternative according to ith criterion was determined by the relation

Table 6
The supermatrix, ***M***.

	Goal	Criteria						
	Website evaluation	Navigability (C_1)	Speed (C_2)	Links (C_3)	Relevancy (C_4)	Richness (C_5)	Currency (C_6)	Attractiveness (C_7)
Goal								
Website evaluation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Criteria								
Navigability (C_1)	0.146	0.000	0.424	0.156	0.188	0.196	0.173	0.429
Speed (C_2)	0.115	0.189	0.000	0.124	0.148	0.153	0.160	0.000
Links (C_3)	0.077	0.000	0.000	0.000	0.000	0.000	0.127	0.000
Relevancy (C_4)	0.156	0.255	0.000	0.170	0.000	0.209	0.170	0.000
Richness (C_5)	0.179	0.281	0.307	0.193	0.236	0.000	0.183	0.571
Currency (C_6)	0.154	0.000	0.000	0.168	0.200	0.208	0.000	0.000
Attractiveness (C_7)	0.173	0.275	0.269	0.189	0.228	0.234	0.187	0.000

Table 7
The limit supermatrix, $\boldsymbol{M^L}$.

	Goal	Criteria						
	Website evaluation	Navigability (C_1)	Speed (C_2)	Links (C_3)	Relevancy (C_4)	Richness (C_5)	Currency (C_6)	Attractiveness (C_7)
Goal								
Website evaluation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Criteria								
Navigability (C_1)	0.221	0.221	0.221	0.221	0.221	0.221	0.221	0.221
Speed (C_2)	0.113	0.113	0.113	0.113	0.113	0.113	0.113	0.113
Links (C_3)	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Relevancy (C_4)	0.125	0.125	0.125	0.125	0.125	0.125	0.125	0.125
Richness (C_5)	0.255	0.255	0.255	0.255	0.255	0.255	0.255	0.255
Currency (C_6)	0.080	0.080	0.080	0.080	0.080	0.080	0.080	0.080
Attractiveness (C_7)	0.196	0.196	0.196	0.196	0.196	0.196	0.196	0.196

$$f_{ij} = \frac{1}{e}\sum_{k=1}^{e} g_{ij}^{k}$$

where g_{ij}^k was the performance value given by the kth expert to the jth alternative according to the ith criterion, and e was the number of experts participating in the evaluation process. The "value function" g had the following properties: $0 \le g \le 100$. The obtained evaluation result was the performance matrix (Table 9). As shown in Table 9, A_2 had the highest global performance value (79.241) among the seven national park websites. This global score was not high enough, as there was dissatisfaction with the "navigability" and "attractiveness" of the website. In contrast, A_6 had the lowest average score (57.366), as each of its criteria had significant improvement margins.

Finally, we determined that a score of 100 represented the positive-ideal solution (f_i^*), and a score of 0 represented the negative-ideal solution (f_i^-). This performance matrix was calculated by using the formula: $[(f_i^* - f_{ij})/(f_i^* - f_i^-)]$ to obtain performance variance rates between the status quo and the ideal point for websites (Table 10). The last column of Table 10 shows weighted average variance rates for the seven criteria. Ranked by the weighted average variance rate, the top-three criteria were richness (C_5), navigability (C_1), and attractiveness (C_7). These three criteria needed the most improvement.

4.3. Application of the modified VIKOR method

Subsequently, we applied the modified VIKOR method to calculate comprehensive performance variance rates for each national park website. In this case, the values of S_j, Q_j^{mod}, and R_j^{mod} were computed by selecting $v = 0.5$ and are shown in Table 11. Looking at this table, the values of R_j^{mod} were (A_1, A_2, A_3, A_4, A_5, A_6, A_7) = (0.281, 0.230, 0.248, 0.272, 0.305, 0.467, 0.378). These results show that A_2 had the best overall performance and was the closest to the ideal solution, followed by A_3, A_4, A_1, A_5, A_7, and A_6. The performance variance rate of A_2 was 0.230. A_2 still had some gaps, however, between the status quo and the ideal point. On the contrary, A_6 was the farthest from the ideal solution, as its R_j^{mod} value (0.467) was larger than all others. Given these results, we observed A_2 did not have an acceptable advantage; in other words, $R(a'') - R(a') = 0.018 \le h^{\mathrm{mod}} = 0.040$. On the other hand, we observed that A_2 was stable within the decision-making process; in other words, it was also the highest ranked in $S(\cdot)$ and $Q^{\mathrm{mod}}(\cdot)$. Because Condition **N1** was not satisfied, we proposed A_2 and A_3 as a set of compromise solutions. The proposed model, however, was superior to the weighted variance method. It not only considered the weighted average variance of each criterion, but also added the lowest performance rating with respect to the specified criterion in the VIKOR index. For example, as shown in the last row of Table 10 and the last column of Table 11, A_3 and A_4 had the same weighted average variance rate (0.231), but A_3 performed better than A_4 using the modified VIKOR method ($0.248 < 0.272$). Thus, the shortcoming of the weighted variance method is that it only takes into account the global weighted average variance rate and neglects to specifically consider the worst one.

4.4. Application of the weight-variance analysis

Phase 4 used WVA to identify the website's strong and weak points. Based on Tables 8 and 10, a coordinate diagram was acquired by mapping the dataset of performance variance rates and ANP weights, where the horizontal axis was "performance variance rate," and the vertical axis was the "ANP weight". Due to space limitations, we only illustrated four WVMs for the two worst websites (A_6 and A_7) and the two best websites (A_2 and A_3). As shown in Figs. 6–9, these four maps could be further divided into four zones each by using the mean values at the crosshair points of the x- and y-axes (i.e., the average performance variance rate (0.276) and the average ANP weights (0.143) of the seven websites).

A_6 was the worst website in the VIKOR ranking. As seen in Fig. 6, immediately noteworthy is the fact that five of the seven criteria fell into the "Concentrate here" zone, including richness (C_5), navigability (C_1), attractiveness (C_7), relevancy (C_4), and speed (C_2). These criteria were above the iso-rating line, and performed poorly in

Table 8
Comparison of the ANP and AHP methods.

Criteria	ANP		AHP	
	Weights	Rank	Weights	Rank
Navigability (C_1)	0.221	2	0.146	5
Speed (C_2)	0.113	5	0.115	6
Links (C_3)	0.010	7	0.077	7
Relevancy (C_4)	0.125	4	0.156	3
Richness (C_5)	0.255	1	0.179	1
Currency (C_6)	0.080	6	0.154	4
Attractiveness (C_7)	0.196	3	0.173	2

Table 9
Average performance scores of the seven websites.

Criteria/Websites	A_1	A_2	A_3	A_4	A_5	A_6	A_7
Navigability (C_1)	75.000	75.000	73.438	76.563	76.563	54.688	73.438
Speed (C_2)	76.563	82.813	75.000	68.750	70.313	60.938	73.438
Links (C_3)	67.188	78.125	82.813	70.313	71.875	50.000	54.688
Relevancy (C_4)	76.563	84.375	82.813	84.375	76.563	67.188	73.438
Richness (C_5)	78.125	81.250	78.125	75.000	71.875	53.125	67.188
Currency (C_6)	78.125	78.125	76.563	85.938	65.625	64.063	65.625
Attractiveness (C_7)	76.563	75.000	76.563	76.563	75.000	51.563	67.188
Average performance scores	75.446	79.241	77.902	76.786	72.545	57.366	67.857

Table 10
Performance variance rates of the seven websites.

Criteria/Websites	A_1	A_2	A_3	A_4	A_5	A_6	A_7	AVR[a]	WAVR[b]
Navigability (C_1)	0.250	0.250	0.266	0.234	0.234	0.453	0.266	0.279	0.062
Speed (C_2)	0.234	0.172	0.250	0.313	0.297	0.391	0.266	0.275	0.031
Links (C_3)	0.328	0.219	0.172	0.297	0.281	0.500	0.453	0.321	0.003
Relevancy (C_4)	0.234	0.156	0.172	0.156	0.234	0.328	0.266	0.221	0.028
Richness (C_5)	0.219	0.188	0.219	0.250	0.281	0.469	0.328	0.279	0.071
Currency (C_6)	0.219	0.219	0.234	0.141	0.344	0.359	0.344	0.266	0.021
Attractiveness (C_7)	0.234	0.250	0.234	0.234	0.250	0.484	0.328	0.288	0.056
Global weighted average variance rate	0.234	0.211	0.231	0.231	0.266	0.434	0.302	0.276	0.039

[a] AVR represents the average performance variance rate of the seven websites (A_1–A_7).
[b] WAVR represents the AVR multiplied by the ANP weight.

comparison with their relative importance. An analysis of ANP weights and the length of the dashed lines suggest managerial priorities for tackling this under-performance. First, richness (C_5) was in most urgent need of improvement because this had the highest weight and longest horizontal distance from the iso-rating. This study suggests that this website should provide a greater variety of tourism information, such as tourism news, an online library, and weather forecasts. Such abundant information can help travellers get to know destinations and make travel plans. Next, greater effort should be paid to improving the criteria of navigability (C_1) and attractiveness (C_7). This study suggests increasing navigation tools and creating advanced functions such as three-dimensional (3D) virtual tours. Moreover, two criteria were located in the "Low Priority" zone, including currency (C_6) and links (C_3). This means that these two criteria were considered not very important, but with low performance, such that managers should not be overly concerned with them. Actions on these two criteria should be delayed until most of the improvement in the "Concentrate Here" zone has been completed. Finally, there was no criterion located in Zone 2 or Zone 3.

A_7 was the second worst website in the VIKOR ranking. As seen in Fig. 7, three criteria were located in the "Concentrate Here" zone, including richness (C_5), navigability (C_1), and attractiveness (C_7). This means that these three criteria had the most urgent need for improvement. Next, two criteria were identified in the "Redeploy Resources" zone, and were rated as having low importance and a low performance variance rate. These were relevancy (C_4) and speed (C_2). This implies that resources currently committed to service improvement in the "Redeploy Resources" zone could be reallocated to potentially more effective utilizations in the "Concentrate Here" zone without significant detriment to overall performance. Moreover, another two criteria falling into the "Low Priority" zone constitute a secondary priority for remedial action. Finally, there was no criterion located in Zone 2.

A_2 was the best website in the VIKOR ranking; however, this website still needed improvement in order to achieve its ideal point or desired level. As seen in Fig. 8, three criteria were located in the "Concentrate Here" zone, including richness (C_5), navigability (C_1), and attractiveness (C_7). The high performance variance rate suggests that improvement in this region must be the top priority. The remaining four criteria were identified in the "Redeploy Resources" zone. Consideration should therefore be given to the possibility of redeploying resources to the "Concentrate Here" zone. In addition, A_3 was the second best website in ranking. As shown in Figs. 8 and 9, the WVM of A_3 is similar to that for A_2.

Table 11
VIKOR ranking of the seven websites ($v = 0.5$).

	S_j		Q_j^{mod}		R_j^{mod}	
	Values	Ranking	Values	Ranking	Values	Ranking
A_1	0.234	3	0.328	4	0.281	4
A_2	0.211	1	0.250	1	0.230	1
A_3	0.231	2	0.266	2	0.248	2
A_4	0.231	2	0.313	3	0.272	3
A_5	0.266	4	0.344	5	0.305	5
A_6	0.434	6	0.500	7	0.467	7
A_7	0.302	5	0.453	6	0.378	6

4.5. Discussion

Table 8 shows the relative importance for each criterion. Of the seven criteria, richness (C_5) appeared to be the most important factor for evaluating websites. The results supported the studies of Bilsel et al. (2006) and Büyüközkan and Ruan (2007), which suggested that information richness plays a predominant role in determining website quality. Nevertheless, the ranking order of other criteria was different in these studies; one of the possible reasons was that we used the integrated DEMATEL-ANP method instead of AHP. The integrated DEMATEL-ANP method solved the problems of the studies of Bilsel et al. (2006), Lee and Kozar (2006) and Büyüközkan and Ruan (2007), which did not take into account interrelationships between criteria. Moreover, our study computed unimproved gaps between the status quo and the ideal point for websites, making it superior to the study of Lee and Kozar (2006), which only ranked four electronics websites and four travel websites by applying AHP, respectively. Furthermore, the results of our

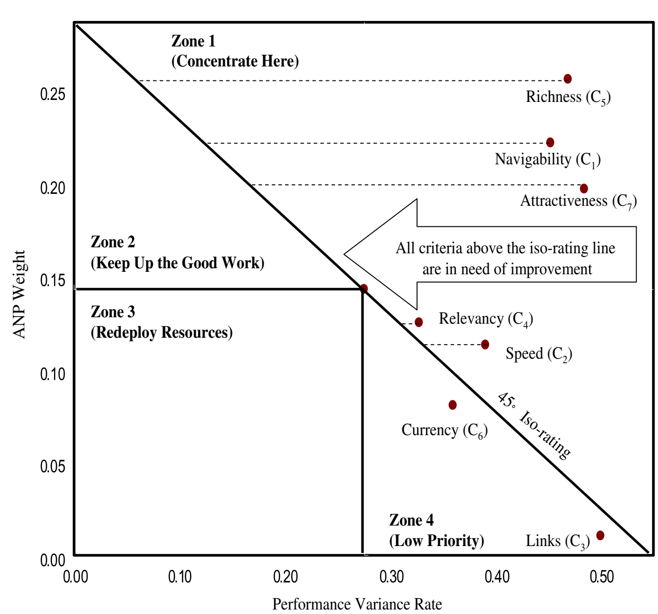

Fig. 6. The weight-variance map for the A_6 website.

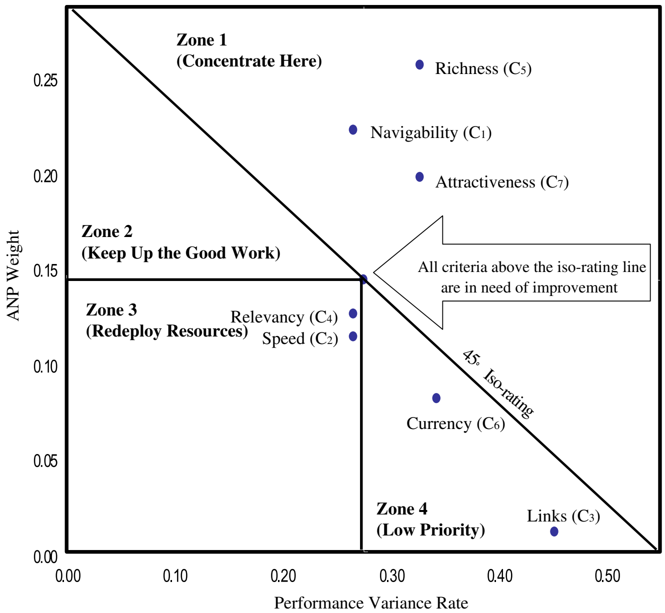

Fig. 7. The weight-variance map for the A_7 website.

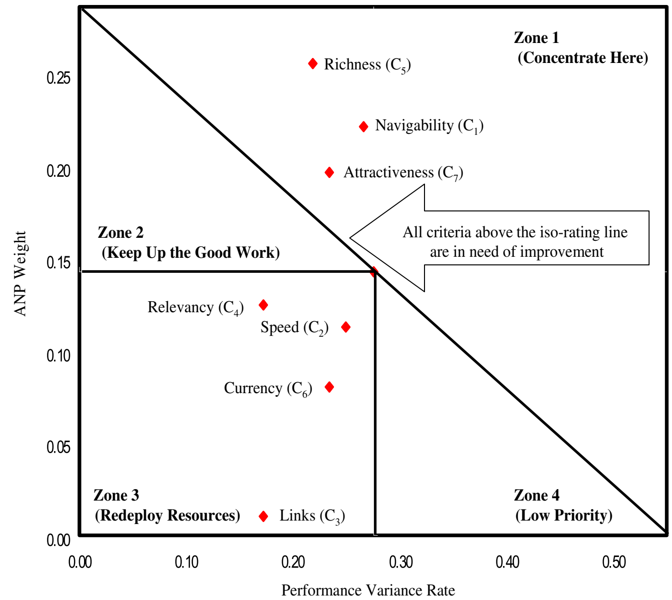

Fig. 9. The weight-variance map for the A_3 website.

study reflected the real ranking of national park websites. Because the TOPSIS method cannot be used for ranking purposes (Wang et al., 2007), our study used VIKOR to overcome the ranking problem of the study of Büyüközkan and Ruan (2007), which incorrectly used Fuzzy TOPSIS to rank 13 government websites. Finally, our study also used WVA to identify the most crucial criteria in need of remedial action. It is also superior to the study of Büyüközkan et al. (2007), which only used Fuzzy VIKOR to rank 21 e-learning websites and did not suggest any improvement actions.

As opposed to an isolated analysis of individual websites, it was useful to compare all seven websites. According to the results in the last column of Table 10, no national parks in Taiwan were utilizing the full range of internet's potential. Their websites performed poorly in terms of richness (C_5), navigability (C_1), attractiveness (C_7), speed (C_2), and relevancy (C_4). The weighted average variance rates for these five criteria were between 0.028 and 0.071. There was still a great deal of room for National Park Headquarters to improve the websites' performance. First, the highest weighted performance variance rate appears for the richness (C_5) criterion, meaning that significant efforts – as compared to other criteria – are required in order to improve website quality. Blogs can be used to increase the richness of travel information; travellers are likely to share their own travel experiences with others and read other traveller's trips through this medium (Litvin, Goldsmith, & Pan, 2008). Only the Taroko National Park's website (A_4) includes space specifically for blogs. The public can apply to have their own blog spot so as to share the beauty of the Taroko Gorge and its other characteristics. Through network sharing, more and more Park visiting experiences and life stories can been seen. The other six websites could consider using blogs to provide information to visitors.

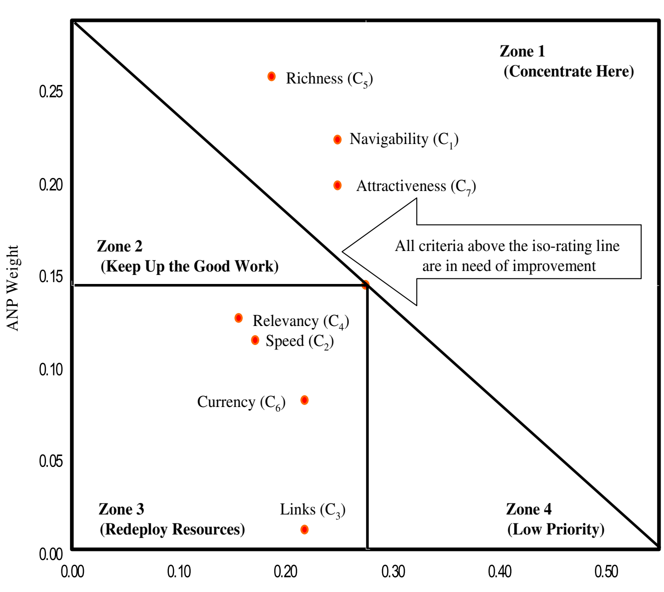

Fig. 8. The weight-variance map for the A_2 website.

Second, the navigability (C_1) criterion had the second highest weight. This is consistent with a recent finding from Lee and Kozar (2006), which asserted that navigability was the second most important quality factor for online visitors who used travel websites. Furthermore, this criterion had the second highest performance variance rate; therefore, national park websites should increase their usage of user-friendly features like "set as home page," "add to favourites," and "quick links" in order to improve this criterion. Currently, only A_5 provides the function to "set as home page" and "add to favourites." Moreover, "search the site" and "site map" were features of all seven websites, but the function "search the site" did not work properly for A_1 and A_6. Hence, this function should be improved to bring it fully into play. In addition, if visitors can find desired information quickly, their satisfaction will be augmented and the site will probably increase its number of its visitors (Miranda-González & Bañegil-Palacios, 2004). Yushan National Park's website (A_2) not only provided numerous hyperlinks to relevant websites, but also clearly identified them as well; therefore, the other six websites could make plans to add search features to their own websites in order to increase their numbers of visitors. Furthermore, ecotourism information should be placed where it will be obvious to find, and should be highlighted and/or provided through hyperlinks to Web pages that visitors might be

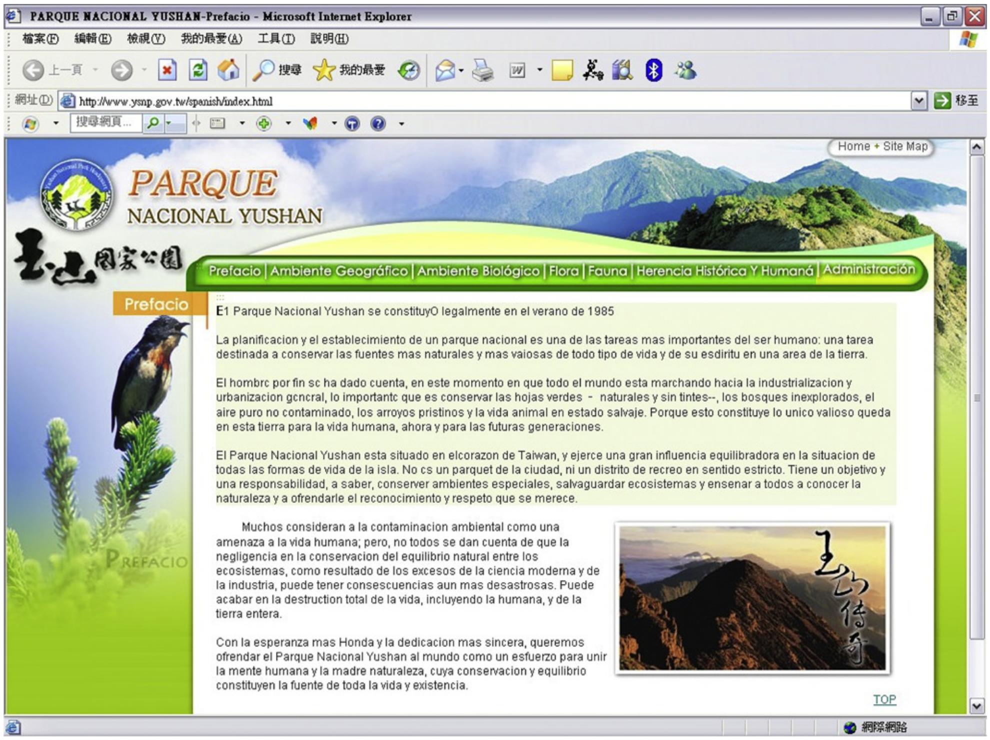

Fig. 10. A Spanish language version of the A_2 website. Source: http://www.ysnp.gov.tw/se/aboutus/index.aspx.

concerned with. A_4 and A_5 need to improve this feature in order to promote ecotourism. It is worth noting that the availability of foreign language options are related to differentiated services offered on the websites (Han & Mills, 2006). According to statistical data from the Taiwanese Tourism Bureau, total foreign visitor arrivals for 2007 reached more than 3.7 million and increased 5.58% over the previous year (Tourism Bureau, 2008b). To take advantage of market opportunities from international tourists, it is necessary to provide multiple languages, such as simplified Chinese, English, Japanese, and French on the national park websites. This function

Fig. 11. The multimedia section of “Cape No. 7” on the A_1 website. Source: http://www.ktnp.gov.tw/manager/pageeditor/stations/cp/10102/index.aspx.

will help international tourists in planning recreation schedules in Taiwan. More potential tourists will then be attracted to accessing detailed tourism information. Nowadays, each national park website has at least three language versions: traditional Chinese, English, and Japanese. The Yushan National Park's website (A_2) also has a Spanish language version (see Fig. 10). This will be expected to capture more European attention.

The attractiveness (C_7) criterion had the third highest weight. This coincides with Cao et al. (2005), who suggest that attractiveness is a significant factor for providing a superior website. Also, this criterion had the third highest performance variance rate and should be further improved in order to achieve an ideal website. An effective website should not only share information, but also create a desire to learn more about a destination, and ideally induce a desire to visit (Litvin et al., 2008). Therefore, the websites could offer online activities and use animation or video clips to enhance attractiveness. For example, the National Park Headquarters could hold various online promotional campaigns for international visitors, such as campaigns for finding new website consultants. Interested participants would provide feedback on website design or arrangement of information in English and Japanese versions, and then help National Park Headquarters design the best website for foreign visitors. The top-three participants, for instance, could also have a chance to win prizes. Multimedia allows tour operators to present appealing images of destinations on their websites (Cai et al., 2004). It should be noted that Kenting National Park's website (A_1) built a dedicated multimedia section to introduce a beautiful spot where a popular film-"Cape No. 7" (Wikipedia, 2008) was shot in order to attract more tourists who like this movie (see Fig. 11). The managers of the other six websites should refer to this feature of A_1 and try to increase the overall appeal of their own websites. In addition, the Kids' version of A_2 and A_6 only provided plain content. These two websites should increase online interaction games and videos in order to attract more children's attention.

The speed (C_2) criterion had the fourth highest performance variance rate. In order to improve this criterion, national park websites could enhance connection speed to internet and shorten download time. Nevertheless, more attractive content takes more time to download and thus increases the cost to the user (Huizingh, 2000). Designers must handle this trade-off between content and speed. Next, the relevancy (C_4) criterion had the fifth highest performance variance rate. Only A_3, A_5 and A_7 had a special function where different groups of browsers could receive disparate guidance. A_5 had the most detailed categorization and divided visitors into four groups, including general travellers, mountaineers, researchers, and students. It offered enough relevant information to be useful to four different groups. Therefore, this study suggests that other websites could try to provide more relevant information for different groups of visitors.

Finally, the operational budget of Taiwanese national park system comes from income taxes paid by individuals and businesses (Tao et al., 2004). If the national parks' budget for maintaining websites is so limited that maintenance efforts can only be devoted to one criterion, then the criterion with the highest weighted variance rate should be the priority. For example, Kinmen National Park's website (A_6) is subject to limited organisational resources; the richness (C_5) criterion should be its top priority because this has the highest weighted variance rate. Contrarily, if the budget is large enough, the links (C_3) criterion (with lowest performance variance rate) could be enhanced by linking to more related websites. A_6 and A_7 have fewer links than the other five websites; they could add related links, such as to the Tourism Bureau and eco-protection.

Furthermore, in order to understand users' perceptions of the performance of national park websites, we invited 16 Ph.D. students who often collect tourist information from travel-related websites to express opinions. Participants were asked to evaluate the seven national park websites on each criterion by using a five-point scale of 1–5 representing "very dissatisfactory" to "very satisfactory." The results are shown in Table 12. As seen in Tables 11 and 12, there were few ranking differences between the experts' and users' opinions. For experts, A_2 was found to be the most preferred choice, followed by A_3, A_4, A_1, A_5, A_7, and A_6. For users, A_2 was the most preferred, followed by A_3, A_1, A_4, A_5, A_7, and A_6. That is, these two tables show that the two best websites (A_2 and A_3) and the two worst websites (A_6 and A_7) were the same between these two groups' opinions.

Table 12
Average user satisfactions of the seven websites.

Criteria/Websites	A_1	A_2	A_3	A_4	A_5	A_6	A_7
Navigability (C_1)	4.688	4.563	4.500	4.125	4.125	3.688	3.750
Speed (C_2)	3.750	4.188	4.125	3.813	3.625	3.563	3.375
Links (C_3)	4.063	4.313	4.375	4.375	4.125	3.688	3.625
Relevancy (C_4)	4.188	4.438	4.500	3.938	3.750	3.563	3.750
Richness (C_5)	4.375	4.500	4.438	4.000	3.750	3.188	3.563
Currency (C_6)	4.250	4.188	4.188	4.250	3.250	3.875	3.125
Attractiveness (C_7)	4.188	4.125	4.063	4.063	3.563	3.063	3.938
Average satisfaction scores	4.214	4.330	4.313	4.080	3.741	3.518	3.589
Ranking	3	1	2	4	5	7	6

Note: Ranking are based on the average scores measured on a Likert's five-point scale from 1 to 5 (1 = very dissatisfactory, 2 = dissatisfactory, 3 = neutral, 4 = satisfactory, 5 = very satisfactory).

In sum, by integrating DEMATEL, ANP, the modified VIKOR, and WVA, the managers of the national parks can see an effective model for comprehensively evaluating their websites, and then undertake actions to achieve ideal quality levels.

5. Conclusions

National parks provide domestic and international visitors with important opportunities to see and experience unique natural, historical, and cultural resources. The relevant recreation and conservation information of national parks can be represented on their websites. This study proposed an integrated model combining the DEMATEL method, the ANP method, the modified VIKOR method, and the WVA method for evaluating national park websites. First, DEMATEL was applied to construct interrelationships between evaluation criteria. Second, the weights of evaluation criteria were determined through ANP. Next, the modified VIKOR method was applied to compute performance variance rates between the status quo and the ideal point for websites, and for ranking the seven national park websites in Taiwan. The results of this study showed that A_2 and A_3 were the two best websites and that A_6 was the worst one. A further analysis with WVA suggested managerial actions based on two-dimensional maps for improving website quality with limited resources. Findings from WVA showed that three criteria were in need of urgent attention on A_2, A_3 and A_7, and five criteria had higher priorities for improvement on A_6. This indicates improvement efforts park managers might consider for the development of their websites. Therefore, our results had practical implications for the managers of national parks. By understanding a website's strengths and weaknesses and comparing these to other websites, the National Park Headquarters can make resource allocation decisions about how to improve the status quo and achieve high quality websites. The main contribution of this study is to offer National Park Headquarters not only a practical tool for evaluating website quality from experts' point of view, but also a heuristic decisional guide for organising limited resources for managerial actions. Furthermore, although this paper is related to national park websites, the proposed model can also be applied and extended to other organisations to handle any evaluation problem with interdependent factors. However, this study also has some limitations. First, survey data were collected from a limited number of visits to each website at a specific time. Due to the highly dynamic nature of these websites, similar studies at different times are quite likely to show different results. A second limitation is the subjectivity of the relative importance and influence of one criterion over another. These weighting and influence introduced subjectivity when setting the judgment matrix by only considering the specified experts' opinions. Concerning future research, it would be beneficial to extend this study to a fuzzy environment.

Acknowledgement

The authors would like to thank the National Science Council of Taiwan for financially supporting this research under Grant NSC97-2410-H-008-029.

References

Abalo, J., Varela, J., & Manzano, V. (2007). Importance values for importance–performance analysis: a formula for spreading out values derived from preference rankings. *Journal of Business Research, 60*(2), 115–121.
Agarwal, R., & Venkatesh, V. (2002). Assessing a firm's web presence: a heuristic evaluation procedure for the measurement of usability. *Information Systems Research, 13*(2), 168–186.
Ahmed, S. M. Z. (2008). A comparison of usability techniques for evaluating information retrieval system interfaces. *Performance Measurement and Metrics, 9*(1), 48–58.
Ahn, T., Ryu, S., & Han, I. (2007). The impact of web quality and playfulness on user acceptance of online retailing. *Information & Management, 44*(3), 263–275.
Aitta, M. R., Kaleva, S., & Kortelainen, T. (2008). Heuristic evaluation applied to library web services. *New Library World, 109*(1/2), 25–45.
Au Yeung, T., & Law, R. (2006). Evaluation of usability: a study of hotel web sites in Hong Kong. *Journal of Hospitality & Tourism Research, 30*(4), 1–22.
Ayağ, Z., & Özdemİr, R. G. (2007). An intelligent approach to ERP software selection through fuzzy ANP. *International Journal of Production Research, 45*(10), 2169–2194.
Bai, B., Law, R., & Wen, I. (2008). The impact of website quality on customer satisfaction and purchase intentions: evidence from Chinese online visitors. *International Journal of Hospitality Management, 27*(3), 391–402.
Baloglu, S., & Pekcan, Y. A. (2006). The website design and internet site marketing practices of upscale and luxury hotels in Turkey. *Tourism Management, 27*(1), 171–176.
Barnes, S. J., & Vidgen, R. (2002). An integrative approach to the assessment of e-commerce quality. *Journal of Electronic Commerce Research, 3*(3), 114–127.
Bilsel, R. U., Büyüközkan, G., & Ruan, D. (2006). A fuzzy preference-ranking model for a quality evaluation of hospital web sites. *International Journal of Intelligent Systems, 21*(11), 1181–1197.
Büyüközkan, G., & Ruan, D. (2007). Evaluating government websites based on a fuzzy multiple criteria decision-making approach. *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems, 15*(3), 321–343.
Büyüközkan, G., Ruan, D., & Feyzioğlu, O. (2007). Evaluating e-learning web site quality in fuzzy environment. *International Journal of Intelligent Systems, 22*(5), 567–586.
Cai, L., Card, J. A., & Cole, S. T. (2004). Content delivery performance of world wide web sites of US tour operators focusing on destinations in China. *Tourism Management, 25*(2), 219–227.
Cao, M., Zhang, Q., & Seydel, J. (2005). B2C e-commerce web site quality: an empirical examination. *Industrial Management & Data Systems, 105*(5), 645–661.
CCPA (Council of Construction and Planning Agency). (2008). National parks of Taiwan. Retrieved 10.07.08, from http://np.cpami.gov.tw/index.php.
Chang, C. W., Wu, C. R., Lin, C. T., & Lin, H. L. (2007). Evaluating digital video recorder systems using analytic hierarchy & analytic network processes. *Information Sciences, 177*(16), 3383–3396.
Chang, H. L., & Yang, C. H. (2008). Do airline self-service check-in kiosks meet the needs of passengers? *Tourism Management, 29*(5), 980–993.
Chen, F. Y., & Chang, Y. H. (2005). Examining airline service quality from a process perspective. *Journal of Air Transport Management, 11*(2), 79–87.
Chiu, Y. J., Chen, H. C., Tzeng, G. H., & Shyu, J. Z. (2006). Marketing strategy based on customer behaviour for the LCD-TV. *International Journal of Management and Decision Making, 7*(2/3), 143–165.
Chu, R. (2001). What online Hong Kong travelers look for on airline/travel websites? *International Journal of Hospitality Management, 20*(1), 95–100.
Doolin, B., Burgess, L., & Cooper, J. (2002). Evaluating the use of the web for tourism marketing: a case study from New Zealand. *Tourism Management, 29*(3), 458–468.
Fontela, E., & Gabus, A. (1976). *The DEMATEL observer*. DEMATEL 1976 Report. Geneva: Battelle Geneva Research Center.
Han, J. H., & Mills, J. E. (2006). Zero acquaintance benchmarking at travel destination websites: what is the first impression that national tourism organisations try to make? *International Journal of Tourism Research, 8*(6), 405–430.
Hassan, S., & Li, F. (2005). Evaluating the usability and content usefulness of web sites: a benchmarking approach. *Journal of Electronic Commerce in Organisations, 3*(2), 46–67.
Ho, C. I., & Chou-Yen, H. T. (2003). An empirical study on the effectiveness of computer-mediated tour information. *Journal of Outdoor Recreation Study, 16*(1), 25–43, (in Chinese).
Ho, C. I., & Lee, Y. L. (2007). The development of an e-travel service quality scale. *Tourism Management, 28*(6), 1434–1449.
Hori, S., & Shimizu, Y. (1999). Designing methods of human interface for supervisory control systems. *Control Engineering Practice, 7*(11), 1413–1419.
Hsu, J. (2007). National parks being managed as window on Taiwan's beauty. Retrieved 10.12.08, from http://np.cpami.gov.tw/en/index.php?option=com_content&task=view&id=514&Itemid=93.
Huizingh, E. K. R. E. (2000). The content and design of web sites: an empirical study. *Information & Management, 37*(3), 123–134.
ISO (International Organisation for Standardization). (1998). *Ergonomic requirements for office work with Visual Display Terminals (VDTs) part 11: Guidance on usability*. Geneva: International Organisation for Standardization.
Jharkharia, S., & Shankar, R. (2007). Selection of logistics service provider: an analytic network process (ANP) approach. *Omega-The International Journal of Management Science, 35*(3), 274–289.
Kasli, M., & Avcikurt, C. (2008). An investigation to evaluate the websites of tourism departments of universities in Turkey. *Journal of Hospitality, Leisure, Sport and Tourism Education, 7*(2), 77–92.
Kim, H. H., & Kim, Y. H. (2008). Usability study of digital institutional repositories. *The Electronic Library, 26*(6), 863–881.
Kim, M., Kim, J. H., & Lennon, S. J. (2006). Online service attributes available on apparel retail web sites: an E-S-QUAL approach. *Managing Service Quality, 16*(1), 51–77.
Lai, J. S. J. (2008). Welcome to Taiwan. Retrieved 08.01.09, from http://tourtaiwanyears.net/en/main1-1.htm.
Law, R. (2007). A fuzzy multiple criteria decision-making model for evaluating travel websites. *Asia Pacific Journal of Tourism Research, 12*(2), 147–159.
Lee, J. W., & Kim, S. H. (2000). Using analytic network process and goal programming for interdependent information system project selection. *Computers and Operations Research, 27*(4), 367–382.
Lee, Y., & Kozar, K. A. (2006). Investigating the effect of website quality on e-business success: an analytic hierarchy process (AHP) approach. *Decision Support Systems, 42*(3), 1383–1401.
Li, C. W., & Tzeng, G. H. (2009). Identification of a threshold value for the DEMATEL method using the maximum mean de-entropy algorithm to find critical services provided by a semiconductor intellectual property mall. *Expert Systems with Applications, 36*(6), 9891–9898.
Lin, C. J., & Wu, W. W. (2008). A causal analytical method for group decision-making under fuzzy environment. *Expert Systems with Applications, 34*(1), 205–213.
Lin, Y. H., Tsai, K. M., Shiang, W. J., Kuo, T. C., & Tsai, C. H. (2009). Research on using ANP to establish a performance assessment model for business intelligence systems. *Expert Systems with Applications, 36*(2), 4135–4146.
Liou, J. J. H., Tzeng, G. H., & Chang, H. C. (2007). Airline safety measurement using a novel hybrid model. *Journal of Air Transport Management, 13*(4), 243–249.
Litvin, S. W., Goldsmith, R. E., & Pan, B. (2008). Electronic word-of-mouth in hospitality and tourism management. *Tourism Management, 29*(3), 458–468.
Ma, X. L., Ryan, C., & Bao, J. G. (2009). Chinese national parks: differences, resource use and tourism product portfolios. *Tourism Management, 30*(1), 21–30.
Martilla, J. A., & James, J. C. (1977). Importance–performance analysis. *Journal of Marketing, 41*(1), 77–79.
Miranda-González, F. J., & Bañegil-Palacios, T. M. (2004). Quantitative evaluation of commercial web sites: an empirical study of Spanish firms. *International Journal of Information Management, 24*(4), 313–328.
Nielsen, J. (1993). *Usability engineering*. Cambridge: Academic Press.
Nielsen, J. (2000). *Designing web usability: The practice of simplicity*. Indianapolis: New Riders.
Nielsen, J. (2003). *Usability 101*. Retrieved 12.04.09, from http://www.useit.com/alertbox/20030825.html.
Opricovic, S. (1998). *Multicriteria optimization of civil engineering systems*. Belgrade: Faculty of Civil Engineering.
Opricovic, S., & Tzeng, G. H. (2002). Multicriteria planning of post-earthquake sustainable reconstruction. *Computer-Aided Civil and Infrastructure Engineering, 17*(3), 211–220.
Opricovic, S., & Tzeng, G. H. (2003). Fuzzy multicriteria model for post-earthquake land-use planning. *Natural Hazards Review, 4*(2), 59–64.
Opricovic, S., & Tzeng, G. H. (2004). Compromise solution by MCDM methods: a comparative analysis of VIKOR and TOPSIS. *European Journal of Operational Research, 156*(2), 445–455.
Opricovic, S., & Tzeng, G. H. (2007). Extended VIKOR method in comparison with outranking methods. *European Journal of Operational Research, 178*(2), 514–529.

Ou Yang, Y. P., Shieh, H. M., Leu, J. D., & Tzeng, G. H. (2009). A VIKOR-based multiple criteria decision method for improving information security risk. *International Journal of Information Technology & Decision Making, 8*(2), 267–287.

Palmer, J. W. (2002). Web site usability, design, and performance metrics. *Information Systems Research, 13*(2), 151–167.

Parasuraman, A., Zeithaml, V. A., & Malhotra, A. (2005). E-S-QUAL: a multiple-item scale for assessing electronic service quality. *Journal of Service Research, 7*(3), 213–233.

Pearson, J. M., Pearson, A., & Green, D. (2007). Determining the importance of key criteria in web usability. *Management Research News, 30*(11), 816–828.

Qi, S., Law, R., & Buhalis, D. (2008). Usability of Chinese destination management organisation websites. *Journal of Travel & Tourism Marketing, 25*(2), 182–198.

Ravi, V., Shankar, R., & Tiwari, M. K. (2005). Analyzing alternatives in reverse logistics for end-of-life computers: ANP and balanced scorecard approach. *Computers & Industrial Engineering, 48*(2), 327–356.

RDEC (Research, Development and Evaluation Commission). (2008). *Accessible web development guidelines*. Retrieved 22.06.09, http://www.webguide.nat.gov.tw/wSite/mp.

Saaty, T. L. (1996). *Decision making with dependence and feedback: The analytic network process* (1st ed.). Pittsburgh: RWS Publications.

Saaty, T. L. (2001). *Decision making with dependence and feedback: The analytic network process* (2nd ed.). Pittsburgh: RWS Publications.

Saaty, R. W. (2003). *Decision making in complex environments–Super decisions*. Retrieved May 12, 2008, from http://www.superdecisions.com/index_tables.php3.

Seyed-Hosseini, S. M., Safaei, N., & Asgharpour, M. J. (2006). Reprioritization of failures in a system failure mode and effects analysis by decision making trial and evaluation laboratory technique. *Reliability Engineering & System Safety, 91*(8), 872–881.

Shee, D. Y., & Wang, Y. S. (2008). Multi-criteria evaluation of the web-based e-learning system: a methodology based on learner satisfaction and its applications. *Computers & Education, 50*(3), 894–905.

Skok, W., Kophamel, A., & Richardson, I. (2001). Diagnosing information systems success: importance–performance maps in the health club industry. *Information & Management, 43*(2), 409–419.

Smith, A. G. (2001). Applying evaluation criteria to New Zealand government websites. *International Journal of Information Management, 21*(2), 137–149.

Tao, C. H., Eagles, P. F. J., & Smith, S. L. J. (2004). Profiling Taiwanese ecotourists using a self-definition approach. *Journal of Sustainable Tourism, 12*(2), 149–168.

Tarafdar, M., & Zhang, J. (2005). Analyzing the Influence of web site design parameters on web site usability. *Information Resources Management Journal, 18*(4), 62–80.

Tourism Bureau. (2008a). Ecotourism. Retrieved 21.12.08, from http://eng.taiwan.net.tw/lan/Cht/travel_tour/subject_introduce.asp?subject_id=11%2B16&sid=54.

Tourism Bureau. (2008b). Attracting more visitors to Taiwan in 2007. Retrieved 03.01.09, from http://www.taiwan.net.tw/lan/Cht/news_event/news_content.asp?id=14134. (in Chinese).

Tsai, W.-H., & Chou, W.-C. (2009). Selecting management systems for sustainable development in SMEs: a novel hybrid model based on DEMATEL, ANP, and ZOGP. *Expert Systems with Applications, 36*(2), 1444–1458.

Tsai, W.-H., Chou, W.-C., & Hsu, W. (2009). The sustainability balanced scorecard as a framework for selecting socially responsible investment: an effective MCDM model. *Journal of the Operational Research Society, 60*(10), 1396–1410.

Tsai, W.-H., & Hsu, J.-L. (2008). Corporation social responsibility programs choice and costs assessment in the airline industry – a hybrid model. *Journal of Air Transport Management, 14*(4), 188–196.

Tsai, W.-H., Hsu, J.-L., Chen, C.-H., Lin, W. R., & Chen, S.-P. (2009). An integrated approach for selecting corporate social responsibility programs and costs evaluation in the international tourist hotel. *International Journal of Hospitality Management*. doi:10.1016/j.ijhm.2009.12.001. Available online 31.12.09.

Tsai, W.-H., Hsu, W., & Lin, W. L. (2009). New financial service development for banks in Taiwan based on customer needs and expectations. *The Service Industries Journal, 30*(14), 1–22.

Tsai, W.-H., Leu, J.-D., Liu, J.-Y., Lin, S.-J., & Shaw, M. J. (2010). A MCDM approach for sourcing strategy mix decision in IT projects. *Expert Systems with Applications, 37*(5), 3870–3886.

Tuzkaya, G., Önüt, S., Tuzkaya, U. R., & Gülsün, B. (2008). An analytic network process approach for locating undesirable facilities: an example from Istanbul, Turkey. *Journal of Environmental Management, 88*(4), 970–983.

Tzeng, G. H., Chiang, C. H., & Li, C. W. (2007). Evaluating intertwined effects in e-learning programs: a novel hybrid MCDM model based on factor analysis and DEMATEL. *Expert Systems with Applications, 32*(4), 1028–1044.

Tzeng, G. H., Lin, C. W., & Opricovic, S. (2005). Multi-criteria analysis of alternative-fuel buses for public transportation. *Energy Policy, 33*(11), 1373–1383.

Tzeng, G. H., Teng, M. H., Chen, J. J., & Opricovic, S. (2002). Multicriteria selection for a restaurant location in Taipei. *International Journal of Hospitality Management, 21*(2), 171–187.

Tzeng, G. H., Tsaur, S. H., Laiw, Y. D., & Opricovic, S. (2002). Multicriteria analysis of environmental quality in Taipei: public preferences and improvement strategies. *Journal of Environmental Management, 65*(2), 109–120.

Van der Merwe, R., & Bekker, J. (2003). A framework and methodology for evaluating e-commerce web site. *Internet Research: Electronic Networking Application and Policy, 13*(5), 330–341.

Wan, C. S. (2002). The web sites of international tourist hotels and tour wholesalers in Taiwan. *Tourism Management, 23*(2), 155–160.

Wang, Y. M., Luo, Y., & Hua, Z. H. (2007). A note on group decision-making based on concepts of ideal and anti-ideal points in a fuzzy environment. *Mathematical & Computer Modelling, 46*(9–10), 1256–1264.

Wey, W. M., & Wu, K. T. (2007). Using ANP priorities with goal programming in resource allocation in transportation. *Mathematical & Computer Modelling, 46*(7/8), 985–1000.

Wikipedia. (2008). Cape No. 7. Retrieved 03.01.09, from http://en.wikipedia.org/wiki/Cape_No._7.

Wu, W. W., & Lee, Y. T. (2007). Developing global managers' competencies using the fuzzy DEMATEL method. *Expert Systems with Applications, 32*(2), 499–507.

Zeithaml, V. A. (2002). Service excellence in electronic channels. *Managing Service Quality, 12*(3), 135–138.