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The effects of online commentary on users' information processing in the context of online discussion forums

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THE DEVELOPMENT OF AN EVALUATION MODEL OF E-COMMERCE WEBSITES FOR THE TAIWANESE AIRLINE INDUSTRY

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Abstract

The airline industry employs advanced e-commerce technologies to retain frequent customers and attract new passengers, but it is likely that not all airlines have clear knowledge about how many gaps should be filled between the status quo and an ideal website. This study proposes an integrated model for evaluating airlines' websites in terms of the perspectives of "marketing mix 4Ps" and "website quality". In order to verify the practicality and usefulness of this model, an empirical study of the Taiwanese airline industry is offered to illustrate the application of the proposed model. The model first applies the DEMATEL method to cope with the interdependencies between criteria. It then converts the criteria's cause and effect relations into a visual structural map where the ANP method can help compute the weight of criteria. Finally, it uses the modified VIKOR method to rank e-commerce websites of the five Taiwanese airlines. Overall, the results show that the Taiwanese airlines still have a great deal of room to improve their websites. This proposed model not only provides helpful information for airlines to understand their websites' quality level, but also contributes to industrial applications in terms of providing some worthwhile recommendations for building an ideal website.

Keywords: Decision Making, E-Commerce, E-Marketing, Web Site Analysis

1 INTRODUCTION

The Internet and information technology (IT) have become common practice of the airline industry and helped sharpen airlines' competitive edge through operation efficiency improvement (Hanke & Teo 2003). One of the most valid solutions for enhancing business values and attracting more customers is to sell low-fair air travel tickets and facilitate boarding processes such as e-ticketing and online check-in through an airline's own website (Wei & Ozok 2005). Currently, many airlines are utilizing dedicated websites to market their products to potential customers. Some airlines also offer discounts to customers who purchase their tickets online (Hanke & Teo 2003). With the ongoing trends of the Internet marketing, this raises the critical issue of how airlines can effectively measure their websites' characteristics. Due to the multidimensional characteristics of website design in this issue, it must be appropriately addressed by multiple criteria decision-making (MCDM) methods.

Nowadays, there is no a standardized model for evaluating e-commerce websites of airlines, and existing ranking methods do not offer enough insights for airlines' proprietors to determine whether their websites meet ideal levels in terms of the perspectives of "marketing mix 4Ps" and "website quality". Therefore, an effective model is proposed that combines the Decision Making Trial and Evaluation Laboratory (DEMATEL) method, the Analytic Network Process (ANP) method, and the modified VIKOR (VlseKriterijumska Optimizacija I Kompromisno Resenje in Serbian, or Multi-criteria Optimization and Compromise Solution) method for an inter-website comparison of airlines. First, the DEMATEL method is applied to deal with the interdependence between evaluation criteria and also to convert the criteria's cause and effect relations into a visual structural map. Next, the ANP method is employed to determine the relative importance of evaluation criteria. The ANP, a relatively new MCDM method, can systematically deal with network-like decision problems. Finally, the modified VIKOR method is used to evaluate and rank the websites of airlines. The VIKOR, a compromise ranking method, had been introduced by Opricovic (1998). It established an aggregating function based on the measure of closeness to the ideal solution. This ranking index of the VIKOR method is an aggregation of all criteria, the relative importance of criteria, and a balance between total and individual satisfaction (Opricovic & Tzeng 2004). Therefore, this integrated model is useful for an airline company to identify the performance level of its website in the airline industry, and then to take necessary actions to improve shortcoming for enhancing competitive advantages.

The purpose of this paper is to build an evaluation model of e-commerce websites for airlines. By suggesting comprehensive measurements based on the perspectives of "e-marketing" and "e-quality", the proposed model can provide helpful information for airlines' proprietors to understand the unimproved gaps of their websites. Moreover, this study contributes to industrial applications in terms of providing some worthwhile recommendations for building an ideal website. In order to verify the practicality and usefulness of this model, an empirical study of the Taiwanese airline industry is offered to illustrate the application of the proposed model.

2 THE CONCEPTS OF E-MARKETING AND E-QUALITY

2.1 The perspective of e-marketing

The Internet is especially valuable for coping with the intangible nature of service and transforming "marketing mix" variables to exploit the informational and transactional potential of the Internet (Baloglu & Pekcan 2006). The "marketing mix" concept was introduced in the 1950s, and the mix of different means of competitions was soon regrouped to 4Ps (i.e. product, price, place, and promotion) by McCarthy (Grönroos 1997). These 4Ps are useful to highlight some unique aspects of e-marketing (Kalyanam & McIntyre 2002).

To update the marketing mix for the Internet, Kalyanam and McIntyre (2002) proposed the e-marketing mix that included new elements such as personalization, privacy policy, and website design. Dutta and Biren (2001) used the 4Ps model comprising customer relationships and technologies of interactivity and connectivity as a tested framework (called the Marketspace Model) for evaluating business transformation on the Internet. Blum and Fallon (2002) examined 53 Welsh visitor attraction websites according to product, price, promotion, place, customer relations, and technical aspects. In addition, Law and Leung (2000) evaluated the efficiency of airlines' online reservation services according to online reservation services, provision of extra benefits, reservation time, and the availability of additional services/facilities.

2.2 The perspective of e-quality

The term "e-quality" is important for assessing e-commerce websites. Aladwani and Palvia (2002) considered Web quality to be a complex thing and multidimensional measurement in nature. Madu and Madu (2002) noted that the dimensions of e-quality may be different from the traditional practice of quality. DeLone and McLean's updated information systems (IS) success model (2003) consists of three quality factors: information quality, system quality and service quality. Parasuraman et al. (1985) conceptualized service quality as the relative perceptual gaps between exceptions and perceptions of performance levels and then developed the gap model as an approach to measure service quality. According to this gap model, the SERVQUAL instrument, which includes the five dimensions of tangibles, reliability, responsiveness, assurance, and empathy, was developed by Parasuraman et al. (1988). Subsequently, Zeithaml et al. (2000) developed e-SERVQUAL to measure electronic service quality as an updated measure of traditional SERVQUAL model in the Web setting. This multi-item scale includes the seven dimensions of efficiency, reliability, fulfillment, privacy, responsiveness, compensation, and contact.

Website evaluation has been widely studied in the literature. Lee and Kozar (2006) evaluated online electronics and online travel websites by adopting DeLone and McLean's IS success model and applying the Analytic Hierarchy Process (AHP) method. AHP can only obtain the relative weights of alternatives; it cannot compute gaps between the status quo and an ideal point. Büyüközkan et al. (2007) used the Fuzzy VIKOR method to evaluate 21 e-learning websites according to seven criteria. They ignored 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 et al. (2007), TOPSIS' closeness coefficient values do not reflect the superiority or inferiority of alternatives and therefore cannot be used for ranking purposes. Baloglu and Pekcan (2006) applied content analysis to analyze the websites of hotels in Turkey in terms of site design and marketing characteristics using a measurement variable of yes-or-no (one-or-zero). The shortcoming of binary variables is that they cannot express the performance on each criterion. Wan (2002) also applied content analysis to evaluate the websites of 30 tourist hotels and 39 tour wholesalers using a 5-point rating scale. He took into account the performance on each criterion, but ignored the relative importance of various criteria. Shchiglik and Barnes (2004) used a 5-point scale and important ratings to evaluate website quality according to four dimensions (i.e. site quality, information quality, interaction quality, and airline-specific quality) for the airline industry in New Zealand. They took into account the global weighted average performance, but neglected to specifically consider the worst one.

As mentioned above, 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 model for assessing e-commerce websites in terms of combined "marketing mix 4Ps" and "website quality" perspectives. This model overcomes the drawbacks of prior studies and offers enough insights for practitioners to accurately measure the current level of their websites according to critical criteria that determine their competitive advantages.

3 AN INTEGRATED EVALUATION MODEL

The assessment process of e-commerce websites required the construction of an evaluation model. To effectively evaluate e-commerce websites of airlines, an integrated MCDM model is proposed. The proposed model includes six phases: (1) defining the goal; (2) establishing the analytic structure; (3) using the DEMATEL method; (4) using the ANP method; (5) applying the modified VIKOR method; (6) finding the ranking of airlines' websites. Accordingly, an overview of the integrated evaluation model for e-commerce websites is shown in Figure 1. The details of each phase are described as follows.

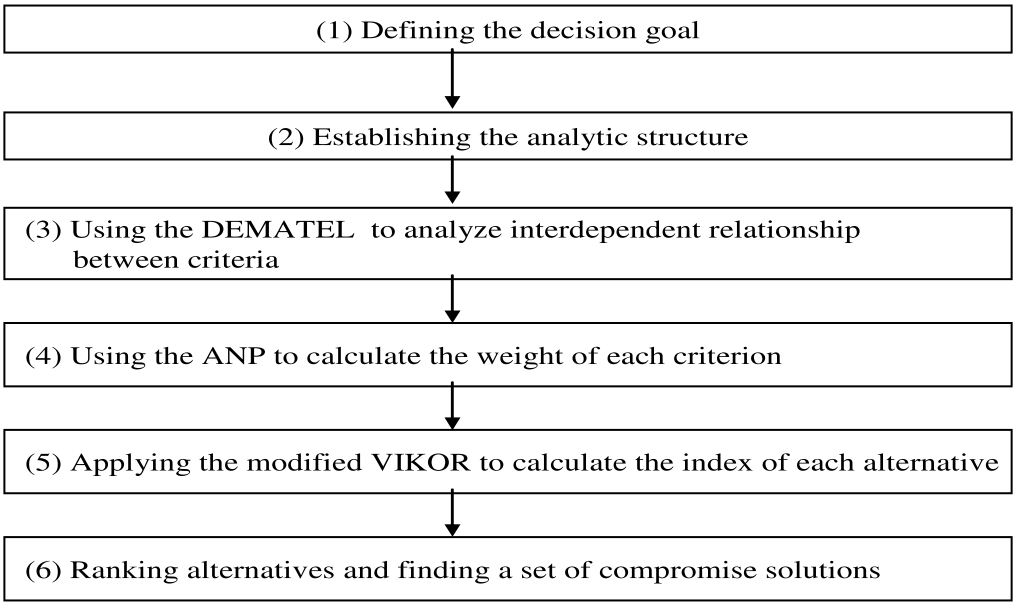

Figure 1. The integrated evaluation model for e-commerce websites.

The first phase defines the decision goal. The goal is to evaluate and rank e-commerce websites for the airline industry. In phase 2, the analytic structure, according to related literature and expert interviews, is used to assess e-commerce websites. The four groups are defined and identified in this structure, including: goals, perspectives, criteria, and alternatives. Such combination shapes an evaluation mechanism for airlines' websites, as shown in Figure 2. As seen in this Figure, this MCDM problem is considered in terms of two perspectives. There is no interrelationship between these two perspectives. On the perspective of "e-marketing," the criteria help airlines create more sales such as advertising, price negotiation, online order and payment, and online community features. They are: "high value-added product (P_1)," "product customization (P_2)," "price negotiation (P_3)," "low price (P_4)," "discount (P_5)," "advertising (P_6)," "communication (P_7)," and "transaction function (P_8)." These eight criteria are then divided into four clusters: product, price, promotion, and place. On the perspective of "e-quality," the criteria support the website's designer to create a high quality website such as a personalized user interface and ease of navigation. They are: "reliability (P_9)," "responsiveness (P_{10})," "credibility (P_{11})," "currency (P_{12})," "relevance (P_{13})," personalization (P_{14})," "navigability (P_{15})," "security (P_{16})." These eight criteria are then divided into three clusters: service quality, information quality, and system quality. In addition, the "alternatives" comprises the five airlines' websites.

Phase 3 applies the DEMATEL method prior to the ANP method in order to improve the procedure for dealing with the interrelationships between criteria. DEMATEL quantifies complex relationships between criteria and converts them into a visible structural map. It has been successfully applied in a wide range of situations such as e-learning programs evaluation (Tzeng et al. 2007), safety measurement (Liou et al. 2007), and social responsibility programs selection (Tsai & Hsu 2008) problems. A series of steps are implemented to complete the analysis of this phase (for a detailed exposition of these steps, please refer to the above mentioned studies). Finally, the strength of interdependence between criteria and an influence-relation-map are determined from the results of the DEMATEL.

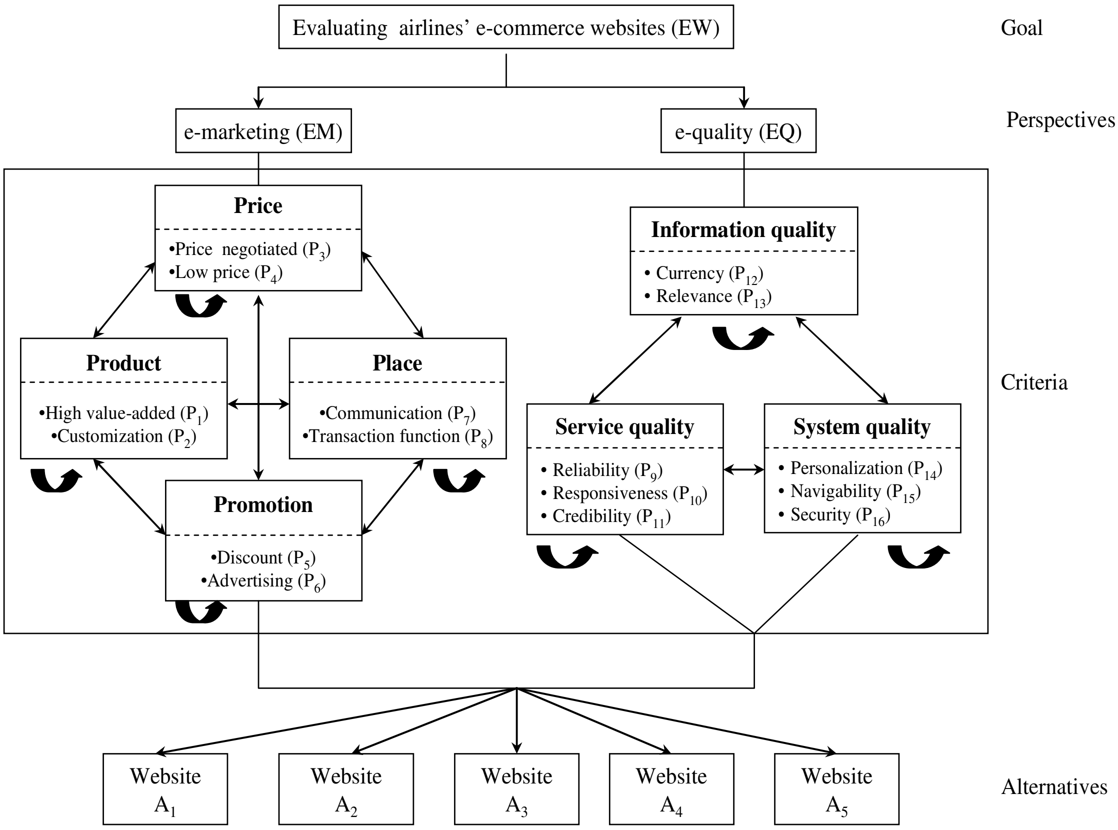

Figure 2. The analytic structure for website evaluation.

Phase 4 applies the ANP method to calculate the relative importance of each criterion. This method is a comprehensive decision-making technique that has the capability to comprise all the interdependent criteria in arriving at a decision (Jharkharia & Shankar 2007). The AHP suffers from the limitation of only being applicable to straightforward hierarchical structures while the ANP can be applicable to the complexities of many real world problems (Chang et al. 2007). In reality, however, such evaluation criteria are seldom independent (Liou et al. 2007). Therefore, instead of adopting the commonly used AHP method for solving these types of problems, we apply an ANP-based model for calculating the weight of each criterion. For the detailed steps of the ANP method the reader is referred to Saaty (2001).

Phase 5 applies the modified VIKOR method to compute gaps between the status quo and an ideal website. The VIKOR method provides measurements of determining the aggregate distance (R_j) to the ideal point. This method considers two distance measurements, S_j and Q_j, based on an aggregating function ($D_p - metric$) in the compromising programming method. D_p represents the distance of an alternative from the ideal solution for different levels of p. S_j is the j^{th} alternative with respect to all criteria as calculated by the average distance from the ideal solution. Q_j is the j^{th} alternative with respect to a specific criterion as calculated by the maximum distance from the ideal solution. The traditional R_j does not indicate how many performance variations exist between the status quo and the ideal point; therefore, following Ou Yang et al. (2008), we use the modified R_j^{mod} index to overcome this drawback. Eq. (1) is used instead of the traditional Q_j. Then, the modified

R_j^{mod} index is listed in Eq. (2).

$$Q_j^{mod} = \max_i \left\{ \left[\left(x_i^* - x_{ij} \right) / \left(x_i^* - x_i^- \right) \right] \mid i = 1, 2, ..., n \right\}, \text{ for } j=1, \ldots, m \tag{1}$$

$$R_j^{mod} = vS_j + \left(1 - v\right) Q_j \tag{2}$$

Finally, phase 6 obtains the ranking of e-commerce websites and a set of compromise solutions according to the modified VIKOR index.

4 AN EMPIRICAL STUDY OF THE AIRLINE INDUSTRY

To describe the proposed model clearly, an empirical study of the Taiwanese airline industry was conducted in order to demonstrate the efficacy of this model for assessing and ranking e-commerce websites. There are five domestic airlines in Taiwan: China Airlines, Eva Air, Uni Air, Mandarin Airlines, and TransAsia Airways. Their e-commerce websites are indicated as A_1 (China Airlines), A_2 (Eva Air), A_3 (Uni Air), A_4 (Mandarin Airlines), and A_5 (TransAsia Airways), respectively. We invited 32 experts to express their opinions in September 2008. Nineteen of them were from various industries and the remaining ones were from academics and research institutes. These experts are professionals who have been designing e-commerce websites or studying on various projects about the Internet marketing for a certain time; therefore, their answers to the questionnaires can appropriately reflect the status quo of e-commerce websites of the five airlines.

4.1 Calculation of the weights of evaluation criteria

First, the experts examined the status quo of the five airlines' websites beforehand and then used the cut-off value method with the 9-point scale to screen for proper criteria. According to the survey results, 16 criteria were constructed as very important to the evaluation of airlines' websites, with a mean value exceeding 6.0 (i.e. cut-off value) for each criterion. Second, a zero–four DEMATEL scale was used for determining the relationship structure among the 16 criteria. Once the relationships between criteria had been measured by the experts, an initial direct-relation matrix could then be obtained. On the basis of the initial direct-relation matrix, a normalized direct-relation matrix was obtained by using the DEMATEL formula. Next, a total-relation matrix (including D, R, D+R and D–R) was identified (Table 1). Finally, a threshold value was chosen as 0.660 to filter the minor effects in the element of the total-relation matrix. After deciding on the threshold value, the influence-relation-map could be obtained by mapping a dataset of (D+R, D–R) (Figure 3).

	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}	**D**	**D+R**	**D-R**
P_1	0.599	0.666	0.735	0.729	0.718	0.670	0.676	0.741	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.534	10.977	0.091
P_2	0.741	0.544	0.752	0.728	0.722	0.676	0.672	0.736	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.571	10.480	0.661
P_3	0.669	0.613	0.619	0.759	0.722	0.640	0.641	0.743	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.405	11.169	-0.359
P_4	0.657	0.581	0.713	0.598	0.728	0.639	0.591	0.691	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.198	10.972	-0.577
P_5	0.638	0.567	0.687	0.723	0.579	0.637	0.587	0.688	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.106	10.806	-0.594
P_6	0.684	0.616	0.709	0.740	0.748	0.550	0.647	0.711	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.405	10.534	0.276
P_7	0.750	0.692	0.803	0.770	0.765	0.685	0.582	0.763	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.810	10.860	0.760
P_8	0.706	0.631	0.746	0.728	0.717	0.632	0.653	0.612	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5.425	11.109	-0.259
P_9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.715	0.799	0.919	0.726	0.729	0.679	0.713	0.799	6.079	11.899	0.260
P_{10}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.756	0.607	0.808	0.676	0.653	0.620	0.652	0.679	5.451	10.985	-0.084
P_{11}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.869	0.790	0.768	0.727	0.733	0.685	0.717	0.803	6.092	11.251	-0.167
P_{12}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.686	0.689	0.740	0.507	0.607	0.560	0.595	0.608	4.992	10.035	-0.050
P_{13}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.706	0.663	0.763	0.618	0.514	0.583	0.613	0.631	5.090	10.114	0.066
P_{14}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.688	0.682	0.748	0.602	0.614	0.491	0.625	0.652	5.101	9.886	0.317
P_{15}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.593	0.568	0.665	0.528	0.518	0.513	0.440	0.536	4.362	9.388	-0.664
P_{16}	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.808	0.737	0.846	0.657	0.656	0.655	0.671	0.606	5.637	10.951	0.323
R	5.443	4.910	5.764	5.775	5.700	5.129	5.050	5.684	5.819	5.535	6.259	5.042	5.024	4.785	5.026	5.314			

Table 1. The total-relation matrix of the 16 criteria.

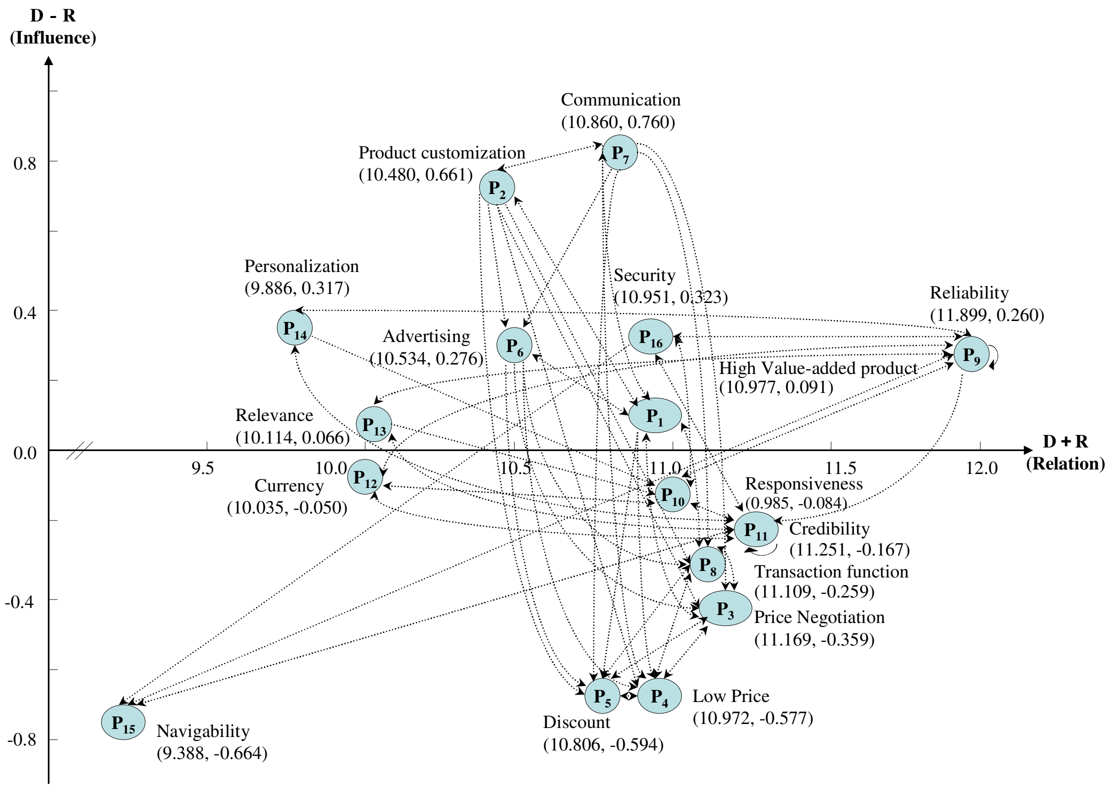

Figure 3. The influence-relation-map the 16 criteria.

As shown in Figure 3, communication (P_7), with the highest value of D–R, was called the master dispatcher. Similarly, product customization (P_2) obtained the second highest value of D–R and became the second powerful criterion. Navigability (P_{15}), with lowest value of D–R, was the master receiver.

Subsequently, the ANP method was employed to determine the relative importance of each criterion. The experts first 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. A scale of one to nine ranges from equal importance to extreme importance (Saaty 2001). Super Decisions 1.6.0 software was applied to aid in the calculations. This software is an easy-to-use tool for constructing network-like decision models with the ability of calculating the weight of each element. Due to space limitations, the pair-wise comparisons are not shown. Second, consistency ratios of all the pair-wise comparison matrices were calculated. The consistency measure is very useful for identifying possible errors in judgments. When consistency ratios are less than 0.1, the judgments are considered to be reliable. In this study, consistency ratios were less than the acceptable threshold value and the eigenvectors displayed were appropriate to enter into the unweighted supermatrix. Third, the experts conducted the pair-wise comparisons on the clusters. Then, the unweighted supermatrix was transformed to be column-stochastic as shown by $\boldsymbol{M}^{\boldsymbol{W}}$ after completing the pair-wise comparisons of the clusters. Finally, the weighted supermatrix was raised to limiting powers of $\boldsymbol{M}^{\boldsymbol{L}}$ to capture all interactions and obtained a steady-state outcome. The limit supermatrix is shown in Table 2. The results of the limit supermatrix yielded (P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8, P_9, P_{10}, P_{11}, P_{12}, P_{13}, P_{14}, P_{15}, P_{16}) = (0.084, 0.024, 0.115, 0.129, 0.130, 0.011, 0.014, 0.128, 0.088, 0.049, 0.081, 0.042, 0.026, 0.015, 0.028, 0.036). Ranked by the weights, the top five evaluation criteria in order of importance were: discount (P_5), low price (P_4), transaction function (P_8), price negotiation (P_3) and reliability (P_9), respectively. This implies that airlines' proprietors need to pay more attention to these five criteria for achieving sustainable competitive advantages in the e-marketplace. Under the perspective of e-marketing, discount (P_5) had the highest weight of 0.130. This criterion is a key factor for successful e-marketing. Apparently, the use of online discount is essential requirement for effective promotion.

		Goal	*Perspectives*		*Criteria*															
					Product		Price		Promotion		Place		Service quality			Information quality		System quality		
		EW	EM	EQ	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}	P_{13}	P_{14}	P_{15}	P_{16}
Goal	EW	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Perspectives	EM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	EQ	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Criteria																				
Product	P_1	0.084	0.133	0.000	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	P_2	0.024	0.038	0.000	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Price	P_3	0.115	0.181	0.000	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.181	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	P_4	0.129	0.203	0.000	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.203	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Promotion	P_5	0.130	0.204	0.000	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.204	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	P_6	0.011	0.018	0.000	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Place	P_7	0.014	0.022	0.000	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	P_8	0.128	0.201	0.000	0.201	0.201	0.201	0.201	0.201	0.201	0.201	0.201	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Service	P_9	0.088	0.000	0.242	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.242	0.242	0.242	0.242	0.242	0.242	0.242	0.242
quality	P_{10}	0.049	0.000	0.133	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.133	0.133	0.133	0.133	0.133	0.133	0.133	0.133
	P_{11}	0.081	0.000	0.222	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.222	0.222	0.222	0.222	0.222	0.222	0.222	0.222
Information	P_{12}	0.042	0.000	0.115	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.115	0.115	0.115	0.115	0.115	0.115	0.115	0.115
quality	P_{13}	0.026	0.000	0.071	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071
System	P_{14}	0.015	0.000	0.041	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
quality	P_{15}	0.028	0.000	0.077	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.077	0.077	0.077	0.077	0.077	0.077	0.077	0.077
	P_{16}	0.036	0.000	0.099	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.099	0.099	0.099	0.099	0.099	0.099	0.099	0.099

Table 2. The limit supermatrix.

4.2 Performance measurement of the websites

After finishing a series of pair-wise comparisons, the experts were asked to provide linguistic values for evaluating the five airlines' websites. 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. The results of evaluation are shown in Table 3. This table shows that all five websites were not utilize the Internet to its full potential and performed poorly in terms of price negotiation (P_3), low price (P_4), responsiveness (P_{10}), and communication (P_7). In addition, a coordinate diagram (Figure 4) was acquired by mapping the dataset of (e-marketing score, e-quality score), where the horizontal axis was "e-marketing" score, and the vertical axis was "e-quality" score. Figure 4 shows that A_2 had the best overall performance and was the closest to the ideal point (A^*). Nevertheless, A_4 was the farthest from the ideal point, both "e-marketing" and "e-quality" performed poorly. These two perspectives needed the most improvement.

Next, the experts determined that a score of 100 represented the positive-ideal solution (x_i^*) and a score of zero represented the negative-ideal solution (x_i^-). The performance score was calculated using normalized formula (i.e. $(x_i^* - x_{ij})/(x_i^* - x_i^-)$) to obtain performance variance rates between the status quo and the ideal point. Finally, S_j, Q_j^{mod}, and R_j^{mod} were computed by selecting v=0.5 (Table 4). Given these results, we observed that A_2 did not have an acceptable advantage; in other words, $R^{[2]}-R^{[1]}=0.001 \leq DR=0.021$. On the other hand, we observed that A_2 was stable within the decision-making process; in other words, it was the highest ranked in $S^{[\cdot]}$. Therefore, we proposed A_1 and A_2 as a set of compromise solutions. Looking at Table 4, the values R_j^{mod} are (A_1, A_2, A_3, A_4, A_5)=(0.436, 0,435, 0.485, 0.518, 0.494), in which the ranking is: $A_2 \succ A_1 \succ A_3 \succ A_5 \succ A_4$, where $A \succ B$ indicates that A is preferred to B.

Criteria/Websites	A_1	A_2	A_3	A_4	A_5	Average
High value-added product (P_1)	77.34	85.16	57.81	51.56	53.91	65.16
Product customization (P_2)	74.22	74.22	57.81	50.00	59.38	63.13
Price negotiation (P_3)	45.31	43.75	43.75	41.41	41.41	43.13
Low price (P_4)	62.50	58.59	57.03	53.13	61.72	58.59
Discount (P_5)	71.09	71.09	61.72	61.72	60.94	65.31
Advertising (P_6)	75.00	73.44	58.59	54.69	62.50	64.84
Communication (P_7)	66.41	73.44	59.38	56.25	59.38	62.97
Transaction function (P_8)	71.09	72.66	62.50	57.03	67.97	66.25
e-marketing average scores	**67.87**	**69.04**	**57.32**	**53.22**	**58.40**	**61.17**
Reliability (P_9)	70.31	74.22	65.63	63.28	63.28	67.34
Responsiveness (P_{10})	72.66	67.19	59.38	52.34	60.16	62.34
Credibility (P_{11})	67.97	78.91	63.28	57.03	60.16	65.47
Currency (P_{12})	76.56	76.56	64.06	60.16	67.19	68.91
Relevance (P_{13})	71.09	72.66	57.03	57.03	58.59	63.28
Personalization (P_{14})	76.56	78.91	56.25	49.22	57.03	63.59
Navigability (P_{15})	77.34	72.66	64.06	51.56	67.19	66.56
Security (P_{16})	63.31	76.56	67.19	61.72	67.19	67.19
e-quality average scores	**71.98**	**74.71**	**62.11**	**56.54**	**62.60**	**65.59**
Overall average scores	**69.92**	**71.88**	**59.72**	**54.88**	**60.50**	**63.38**

Table 3. Average performance scores.

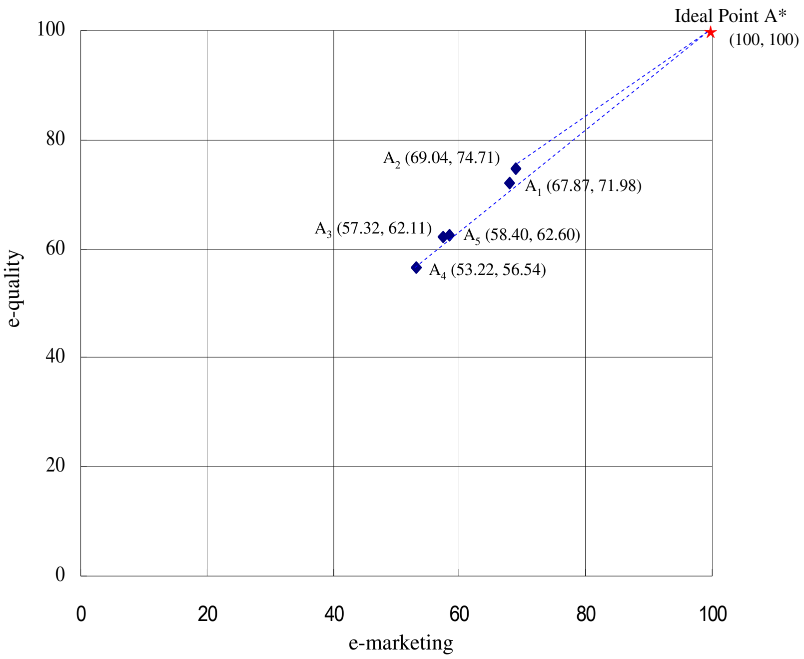

Figure 4. The coordinate diagram of average performance scores.

The results show that the comprehensive variance rate of A_2 was 0.435. This website still needed improvement in order to achieve its ideal point or desired level. On the other hand, A_4 was the farthest from the ideal solution, as its R_j^{mod} (0.518) was larger than all others. A particular attention should be given to price negotiation (P_3) and low price (P_4) because these two criteria had higher weights and lower performance than others. Price negotiation (P_3) was in most urgent need of improvement for airlines' proprietors. Consideration should also be given to the possibility of developing an "online price negotiation" area for special customers such as group traveler. In addition, we suggested that the airlines should try to improve their pricing mechanisms.

Websites	S_j Value	S_j Ranking	Q_j^{mod} Value	Q_j^{mod} Ranking	R_j^{mod} Value	R_j^{mod} Ranking
A_1	0.324	2	0.547	1	0.436	2
A_2	0.308	1	0.563	2	0.435	1
A_3	0.408	4	0.563	2	0.485	3
A_4	0.450	5	0.586	3	0.518	5
A_5	0.403	3	0.586	3	0.494	4

Table 4. Ranking of the five websites by VIKOR (v=0.5).

4.3 Discussions

The value of the weight v had a central role in the ranking of alternatives. According to the VIKOR, when v was larger (>0.5), the value R_j will prefer majority rule. A scenarios analysis can be undertaken by setting v systematically to some values between 0 and 1. To give a valuable insight for the change of evaluators' preferences (or concerns), we proposed another six scenarios for evaluating e-commerce websites; six sets of different weights were associated with six scenarios. Table 5 presents six sets weight values and the ranking of the VIKOR. The results of this table indicated that alternative A_1 was the best ranked, with an acceptable advantage, for scenario 1. From scenario 2 to scenario 6, the compromise sets were obtained $\{A_1, A_2\}$, the first ranked alternative had no advantage to be a single solution.

It was interesting, however, to note that the value S_j of A_2 was the smallest in Table 4 but the value R_j^{mod} of A_2 was the second smallest in scenario 2 and scenario 3. In other words, A_2 had the smallest average variance rate, but it only obtained the second ranking order in the VIKOR method. Moreover, A_2 had the smallest variance rate and the best ranking order in scenario 4, scenario 5 and scenario 6. On the other hand, when v was smaller than 0.5, A_1 had the smallest variance rate and the best ranking order. A_4 had the largest variance rate and the worst ranking order in all scenarios. According to the results of these scenario analyses, we could find the benefits of the VIKOR method since it additionally considers the value Q_j^{mod} which is the farthest from the positive-ideal solution (i.e. the largest variance rate) in the VIKOR index. On the contrary, the shortcoming of traditional performance evaluation is that it only takes into account weighted average scores and neglects to specifically consider the worst one. Thus, the decision-makers can select a suitable weight (v) in terms of their preferences (or concerns) to make an appropriate decision.

	Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5		Scenario 6	
	R_j^{mod} (v= 0)		R_j^{mod} (v= 0.2)		R_j^{mod} (v= 0.4)		R_j^{mod} (v= 0.6)		R_j^{mod} (v= 0.8)		R_j^{mod} (v= 1)	
Websites	Value	Ranking	Value	Ranking	Value	Ranking	Value	Ranking	Value	Ranking	Value	Ranking
A_1	0.547	1	0.502	1	0.458	1	0.413	2	0.369	2	0.324	2
A_2	0.563	2	0.512	2	0.461	2	0.410	1	0.359	1	0.308	1
A_3	0.563	2	0.532	3	0.501	3	0.470	3	0.439	3	0.408	4
A_4	0.586	3	0.559	5	0.531	5	0.504	5	0.477	5	0.450	5
A_5	0.586	3	0.549	4	0.513	4	0.476	4	0.440	4	0.403	3
Compromise solutions	A_1		A_1, A_2		A_1, A_2		A_1, A_2		A_1, A_2		A_1, A_2	

Table 5. Ranking of the five websites in six scenarios.

5 CONCLUSIONS

In view of the pressure from the current fierce competition and high oil costs, airlines gradually turn to the Internet marketing methods to increase competitive advantage. Airlines are concerned about how to build an ideal e-commerce website by comprehensively considering the role of a website on technology, service and marketing constructs.

This study proposed an integrated model combining the DEMATEL method, the ANP method and the modified VIKOR method for evaluating e-commerce websites of airlines and provided some directions to airlines on how to improve overall e-commerce performance. First, the DEMATEL were used to construct the interrelationships between criteria. Second, the ANP were employed to calculate the relative importance of each criterion. The weights obtained through ANP were then combined with the modified VIKOR method to compute performance variance rates between the status quo and the ideal point for ranking the five Taiwanese airlines' websites. The results showed that A_1 and A_2 were the two best websites and that A_4 was the worst one. Moreover, a scenario analysis based on the change of experts' preferences was also provided. The objective of scenario analyses was to provide an insight to decision-makers when a parameter was changing. Finally, the overall results showed that the Taiwanese airlines did not utilize the Internet to its full potential and still had a great deal of room to improve their websites. All five websites performed poorly in terms of price negotiation (P_3), low price (P_4), responsiveness (P_{10}), and communication (P_7). To apply the Internet marketing effectively, these airlines should put efforts to add an "online price negotiation" feature to site and adjust pricing strategies. Airlines can use their websites to gather information about customer needs, buying patterns and preferences. This information can be a worthwhile input to the development of high value-added products and services. Furthermore, although this paper is related to the airline industry in Taiwan, the same concept can be applied and extended to other industries to handle any evaluation problem with interdependent criteria. 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. Second, this study transformed linguistic values into five crisp numerical values for measuring a website's performance, but this might not be true in the real world. Concerning future research, it would be beneficial to extend this study to a fuzzy environment. In addition, the benchmarking analysis provides a means to enhance the websites' competitive advantages by learning from the best practices of the industry. Researchers could also extend this study to the benchmarking analysis.

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