



A new hybrid MCDM model combining DANP with VIKOR to improve e-store business

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ARTICLE INFO

Article history:

Received 14 November 2011

Received in revised form 30 June 2012

Accepted 30 June 2012

Available online 11 July 2012

Keywords:

e-Store business

Internet stores

Customers' needs

Marketing strategies

Multiple Criteria Decision-Making (MCDM)

DEMATEL

Analytic Network Process (ANP)

DEMATEL-based ANP (DANP)

VIKOR

ABSTRACT

Many consumers today buy products and services from e-stores. Because e-store managers are responsible for allocating different resources, it is essential that they understand consumers' shopping behaviour to provide the best possible value for visitors to their websites. Therefore, the purpose of this article is to focus on assessing and improving strategies to reduce the gaps in customer satisfaction caused by interdependence and feedback problems among dimensions and criteria to achieve the aspiration level. We propose a new hybrid Multiple Attribute Decision Making (MADM) model, combining the Decision Making Trial and Evaluation Laboratory (DEMATEL), DEMATEL-based Analytic Network Process (DANP), and Višekriterijumsko Kompromisno Rangiranje (VIKOR) methods to solve these problems. Then, three real cases are used to illustrate how the proposed new hybrid Multiple Criteria Decision-Making (MCDM) model improves e-store business. These results can provide e-store managers with a knowledge-based understanding of how to create marketing strategies that reduce the performance gaps of dimensions and criteria to satisfy consumers' needs and encourage customers to purchase more.

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1. Introduction

It has become increasingly common for consumers to buy products and services from e-stores because these types of stores provide them with a convenient and fast shopping environment and high-quality products and services, saving them time and money. E-stores have become an important retailing channel, and many such stores have been established and are experiencing a continuous increase in sales. Therefore, this article focuses on the assessment, improvement, and setting of strategies to better meet customer needs. These needs are met by reducing performance gaps introduced by interdependence and feedback problems among dimensions and criteria, allowing the aspiration level to be achieved and promoting customer satisfaction to bring people real happiness. It is essential for e-store managers to know how to manage business and marketing strategies because the success of the store depends on excellent management and accurate marketing strategies.

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Electronic commerce (EC) is defined as the process of buying, selling, or exchanging products, services, advertisements, and information via electronic communication technologies (the Internet and www, PDAs (Personal Digital Assistants), smartphones, and tablet computers). Those technologies facilitate the manufacturing of products and the provision of services to satisfy the wants and needs of consumers [4,51,66]. EC includes e-stores, and because shopping is a complex behaviour composed of rational choices, amusement, and social communication [87,90], understanding consumers' wants and needs is critical for the stores' successful management and development [27,90]. This understanding particularly applies to e-stores, in which consumers' shopping behaviour may be different from that in traditional brick-and-mortar stores [71,91]. Therefore, e-store management issues are a hot topic because such stores seek to extend their consideration sets and improve consumers' welfare, and the quality and quantity of individually customised interfaces can facilitate a better, more efficient purchase decision-making process [62,88].

Previous EC researchers have focused on the consumers' motivations [30,71], the shopping behaviour [39,81], the intelligent agents [43,86], the satisfaction-loyalty relationship [5,15,63], and the risk [10]. This research has focused on how to manage e-stores and create marketing strategies. Previous relation methods have focused on influence [38], assessment [13], ranking [37,92],

selection [18,36,47,49,60,72], and improvement [14,21,46,48,50,51,59,83,85]. Thus, this study seeks a new hybrid Multiple Attribute Decision Making (MADM) model combining the Decision Making Trial and Evaluation Laboratory (DEMATEL) technique to build an influential relationship among dimensions and criteria, DEMATEL-based ANP (DANP) to find the influential weights, and Višekriterijumsko KOmpromisno Rangiranje (VIKOR) methods to assess performance, not only in ranking and selection but also in improving and creating e-store marketing strategies to reduce gaps in each dimension and criterion to promote the e-store environment and satisfy customers' needs. These processes can not only help e-store managers to understand customers' wants and needs, they can also assist them in improving their products and service to reduce performance gaps in customer satisfaction by building an effective e-store marketing strategy.

An empirical study of three e-stores – Yahoo, PChome, and Books aims to demonstrate the proposed new hybrid Multiple Criteria Decision-Making (MCDM) model for ranking and improvement. Because this study focuses on the effects of certain influential relationships among dimension and criteria in an e-store business and the creation of marketing strategies for the e-store manager, this study surveyed three e-stores to determine the best strategies for improving an e-store. From the survey results, we found that prioritising the customers' needs and giving them perfect post-purchase service can affect customers' purchase decisions, information searches, and evaluation of alternatives. Therefore, initial marketing strategies can include advertisements and light products to meet the customers' needs. Then, the e-store can create high-quality post-sales service programmes, offer fast delivery of products, provide complete packaging, communicate after the purchase, offer guarantees, and implement liberal returns policies to improve post-purchase service.

The remainder of this paper is organised as follows: Section 2 reviews the consumer decision-making process and evaluation framework, including e-store business criteria and performance. Section 3 provides a brief introduction of the DEMATEL technique, the DANP influential weights and the VIKOR method used to establish a new hybrid MCDM model to resolve problems of interdependence and feedback. An empirical study of Yahoo, PChome, and Books is presented in Section 4 to demonstrate the proposed model and, finally, conclusions and remarks are presented in Section 5.

2. Review of consumers' decision-making process and evaluation framework

An e-store markets and sells products or services offered by a company [54]. E-stores are becoming critically important to online retailers, and they have become important parts of retailer strategy [30]. Therefore, knowing the needs of customers and how to meet those needs is important. E-stores are a highly visible, well-received, and popular type of e-commerce [20,26] that sells products and services online [8,67]. E-stores are part of the e-commerce and retail channel, which includes online retailers, online stores, online shops, e-shops, and any virtual shopping websites that sell products or services from businesses to customers, such as Amazon [35,75,89]. Amazon.com was established in 1994 during an era of rapid growth for the Internet, which quickly became a key channel for the sale of products and services [2,40,77,78]. Consequently, e-store management is a key issue for the development of e-commerce.

The number of e-stores has grown quickly because they are convenient, eliminate sales pressure, and save time. The online retail sales of European e-stores increased 18% from 2009 to 2010 [9]. Forrester research forecasts that European online sales will have a compound annual growth rate of 12%, from €96.7 bn (£82.0 bn) in

2011 to €171.9 bn (£145.8 bn) in 2016 [22,32]. The UK Office for National Statistics reports that e-store sales increased by 13.1% in March 2011 [56]. Forrester research forecasts UK online sales will have compound annual growth rate of 11%, from £30.1 bn in 2011 to £51.0 bn in 2016, and the UK's proportion of online shoppers will increase from 75% of the population in 2011 to 85% in 2016. The proportion of online shoppers in Sweden will increase from 72% of the population in 2011 to 86% in 2016 [22,32]. In the US, Forrester research forecasts that online retail sales are expected to grow from US\$176.2 bn in 2010 to US\$278.9 bn in 2015, which is an increase of more than 10% [53]. Forrester research forecasts note that US online shoppers will have a compound annual growth rate of 15%, from 167 million people in 2012 to 192 million people in 2016, and it is predicted that each consumer's spending will grow by 44%, from US\$1207 in 2012 to US\$1738 in 2016. Therefore, the total sale value for e-stores will increase by 45%, from US\$226 bn in 2012 to US\$327 bn in 2016 [52,69]. All available reports indicate that sales by e-stores are growing rapidly in all areas.

Customer satisfaction has been considered most important issues for marketers and customer researchers [42,55,73]. Companies need to develop strategies that help company develop sustainable business practices [41]. E-store should to meet customers' needs [65] and increase customer satisfaction by creating customer value in consumer marketing [19,64]. Loyal customers that indulge in repeat purchases are the bedrock of any business [1]. Customer satisfaction is important mostly because of its indirect influence on the profitability of companies [3]; satisfied customers tend to make not only more purchases but also repeat purchases [7,74,76], and customer satisfaction has become a key element of many companies' business strategies [24]. Therefore, understanding the criteria that influence customer satisfaction is important not only to describe the actual situation but also to plan improvements, and actions [79].

Marketing activities should be designed to increase customer satisfaction [33]. Therefore, in this paper, we combined consumer behaviour and customer satisfaction to create dimensions and criteria that show the influence level, weighting, and performance among dimensions and criteria.

This study primarily examines consumers' criteria for the business-to-consumer electronic commerce (B2C e-commerce) of e-stores, focusing on consumer satisfaction. E-store buyer behaviour refers to consumer behaviour, and the steps in the consumers' decision-making process can be found in most textbooks and journals, some of which describe these steps as need recognition, information search, evaluation, purchase, and after-purchase evaluation [23,28,29,34,61,68,89]. Others propose that the steps are need recognition, information search, evaluation, purchase, and post-purchase behaviour [44,82]. In fact, according to e-store customers' behaviour, including blog writing, Facebook reviews, and tendency to repurchase, the main components of this process can be considered to be need recognition, information search, evaluation, purchase, and post-purchase behaviour. Based on these criteria, Bizrate.com and Alexa.com conducted surveys asking respondents to rate retailers on 14 e-store attributes, namely, product availability, ease of finding, overall look and design, clarity, number of reviews, brand, relative price, selection, variety of shipping options, shipping charges, charge statement, order tracking, on-time delivery, and expectations met [31]. A detailed description of these components is provided in Table 1. In summary, the intact criteria, which include five influential dimensions and fourteen criteria, need to be considered (see Table 1).

Having surveyed several Taiwan EC websites, Chang and Chen [12] found that, according to users, Yahoo.com, Yahoo auction, PChome.com, and Books.com were the four top online shopping sites [12]. Another study [80] found that the most popular website

Table 1
Reorganisation of the current research. Source: Engel et al., [95], [68,31].

A.	Need recognition Product availability (a_1)	Products you want or need to be available
B.	Information search Ease of finding (b_1) Overall look/design (b_2) Clarity of product information (b_3)	How easily you were able to find information about the products How you feel about the overall look and design of the website How clear and understandable the information about the products is
C.	Evaluation of alternatives Number of Reviews (c_1) Brand (c_2) Prices relative (c_3)	How many reviews are there of other people's overall rating and experience of this purchase How much consumers trust the website's brand How the prices compare to other web-sites
D.	Choice/Purchase Selection (d_1) Variety of shipping options (d_2) Shipping charges (d_3) Charges statement (d_4)	Types of products available The desired shipping options were available Cost of shipping/delivery Total purchase amount (including shipping/handling charges, etc.) displayed before order submission
E.	Post-purchase behaviour Order tracking (e_1) On-time delivery (e_2) Product expectations met (e_3)	Ability to track orders until delivered Products were in stock at time of expected delivery Correct products were delivered and everything worked as described/depicted

was Yahoo (45.1%), followed by PChome (7.8%), Books.com (6.8%), and Ezfly (5.3%), which accounted for 65% of all responses. An earlier study by Chang and Chen [11] found that the ten websites most often visited were Yahoo! (30.1%), Unimall (17.4%), PChome (9.9%), Etmall (9.4%), Books (6.7%), Payeasy (5.1%), Hermall (3.8%), Happybag (2.9%), Eztravel (2.5%) and era ticket (2.4%) [11]. Therefore, this study chooses the three most popular e-stores (i.e., Yahoo, PChome, and Books) to demonstrate the proposed method.

3. Building a new hybrid MCDM model for e-store management

This research uses the DEMATEL technique and combines a DANP with a VIKOR method to establish a new hybrid MCDM model to address the problems of interdependence and feedback among certain criteria and reduce the performance gap in each dimension and criterion. The DEMATEL technique is used to build an influential network relations map (INRM), and the DEMATEL-based Analytic Network Process (DANP) is expected to obtain the influential weights using the basic concept of Analytic Network Process (ANP) [70]. Then, the VIKOR method with influential weights (DANP) is used to integrate the performance gaps from criteria to dimensions and overall. Then, it is possible to determine how to improve business performance and reduce the gaps to achieve the aspiration level and satisfy the customers' needs based on INRM. The research processes are illustrated as Fig. 1.

3.1. DANP (DEMATEL-based ANP)

This study seeks to assess business performance, which usually consists of multiple dimensions and criteria and to determine the influential weights of those criteria. In a traditional ANP, normalisation is set by dividing each criterion in a column by a number of clusters so that each column achieves exact unity. This process

implicitly assumes that each cluster has the same weight. However, it is well-known that the effect of one cluster on the other clusters may be different in degree. Thus, the traditional ANP assumption that each cluster is of equal weight in obtaining a weighted supermatrix is not reasonable; consequently, the DANP influential weights can improve this shortcoming and obtain results based on the basic concept of the ANP from a total-influential matrix T_c and T_D by using the DEMATEL technique. Therefore, the DEMATEL technique is used to build an INRM for each criterion and dimension and also to improve the normalisation process of the traditional ANP. The DANP is an appropriate tool to include interaction and interdependence among the dimensions and criteria that appear in the cases of real world problems. According to the concrete characteristics of objective affairs, the methodology can verify the interdependence of variables and attributes, building a relationship that reflects those characteristics with an essential system and evolutionary trend [38,47,51,59,72,83,85,92]. This technique has been successfully applied to many situations, such as improving marketing, tourism policy, airline partner selection, information security risk control, and environment watershed plans [18,21,47,51,59].

The steps for building an INRM using the DEMATEL technique (steps 1–4) and finding the influential weights of a DANP based on a total-influential matrix (steps 5–9) are summarised below.

3.1.1. DEMATEL technique for building an INRM

Step 1: Calculate the direct-influence matrix by scores. An assessment of the relationship between each mutual influence criterion is made according to the opinions of knowledge-based experts, using a scale ranging from 0 to 4, with scores represented by natural language: 'absolutely no influence' (0), 'low influence' (1), 'medium influence' (2),

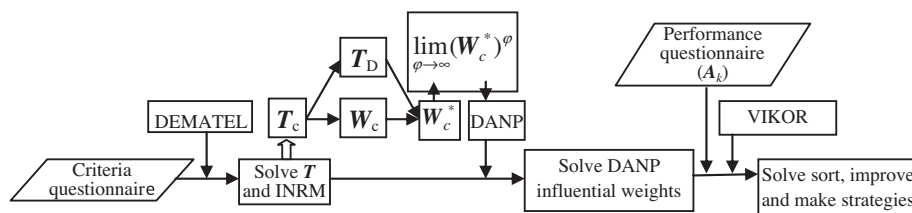


Fig. 1. Model procedure of the current research.

‘high influence’ (3), and ‘very high influence’ (4). The knowledge-based experts are required to indicate the direct influence by a pairwise comparison, and if they believe that criterion i has an effect and influence on criterion j , they should indicate this by g_c^{ij} . Thus, the matrix $G = [g_c^{ij}]_{n \times n}$ of direct relationships can be obtained.

$$G = \begin{bmatrix} g_c^{11} & \dots & g_c^{1j} & \dots & g_c^{1n} \\ \vdots & & \vdots & & \vdots \\ g_c^{i1} & \dots & g_c^{ij} & \dots & g_c^{in} \\ \vdots & & \vdots & & \vdots \\ g_c^{n1} & \dots & g_c^{nj} & \dots & g_c^{nn} \end{bmatrix} \quad (1)$$

Step 2: **Normalise the direct-influence matrix G .** The normalised matrix X is acquired by using Eq. (2). Its diagonal is zero, and the maximum sum of rows or columns is one.

$$X = \nu G \quad (2)$$

where

$$\nu = \min_{ij} \left\{ \frac{1}{\max_i \sum_{j=1}^n g_c^{ij}}, \frac{1}{\max_j \sum_{i=1}^n g_c^{ij}} \right\}, \quad i, j \in \{1, 2, \dots, n\}$$

Step 3: **Attain a total-influential matrix T_c .** When the normalised direct-influential matrix X is obtained, the total-influential matrix T_c of the INRM can be obtained from Eq. (3), in which I denotes the identity matrix,

$$\begin{aligned} T_c &= X + X^2 + X^3 + \dots + X^\ell \\ &= X(I + X + X^2 + \dots + X^{\ell-1})(I - X)^{-1} \\ &= X(I - X^\ell)(I - X)^{-1} = X(I - X)^{-1}, \text{ when } \lim_{\ell \rightarrow \infty} X^\ell \\ &= [0]_{n \times n} \end{aligned} \quad (3)$$

where $X = [x_c^{ij}]_{n \times n}$, $0 \leq x_c^{ij} < 1$, $0 < \sum_{j=1}^n x_c^{ij} \leq 1$, and $0 < \sum_{i=1}^n x_c^{ij} \leq 1$, and at least one row or column of the summation (but not all) equals one; then, $\lim_{\ell \rightarrow \infty} X^\ell = [0]_{n \times n}$ can be guaranteed.

Step 4: **Analyse the results.** At this stage, the row sums and the column sums of the matrix components are separately expressed as vector $r = [\sum_{j=1}^n t_c^{ij}] = (r_1, \dots, r_i, \dots, r_n)'$ and vector $s = [\sum_{i=1}^n t_c^{ij}] = (s_1, \dots, s_j, \dots, s_n)'$ by using Eqs. (4) and (5). Let $i=j$ and $ij \in \{1, 2, \dots, n\}$; the horizontal axis vector $(r_i + s_i)$ is then defined by adding r_i to s_i , to illustrate the importance of the criterion. Similarly, the vertical axis vector $(r_i - s_i)$ is defined by subtracting r_i from s_i , which may divide the criteria into a causal cluster and an affected cluster. In general, when $(r_i - s_i)$ is positive, the criterion is part of the causal group; i.e., criterion i affects other criteria. By contrast, if $(r_i - s_i)$ is negative, the criterion is part of the affected group; i.e., criterion i is influenced by other criteria. Therefore, a causal graph can be achieved by mapping the data set of $(r_i + s_i, r_i - s_i)$, the so-called INRM, to provide a valuable approach to decide how the preferred values in each dimension and criterion can be improved based on the INRM,

$$\begin{aligned} T_c &= [t_c^{ij}]_{n \times n}, i, j \in \{1, 2, \dots, n\} \\ r &= \left[\sum_{j=1}^n t_c^{ij} \right]_{n \times 1} = [t_c^i]_{n \times 1} = (r_1, \dots, r_i, \dots, r_n)' \end{aligned} \quad (4)$$

$$s = \left[\sum_{i=1}^n t_c^{ij} \right]_{1 \times n} = [t_c^j]_{n \times 1} = (s_1, \dots, s_j, \dots, s_n)' \quad (5)$$

where vector r and vector s express the sum of the rows and the sum of the columns from the total-influential matrix $T_c = [t_c^{ij}]_{n \times n}$, respectively, and the superscript ' denotes the transpose [17]. Two different total influence matrices are then applied. The first one, $T_c = [t_c^{ij}]_{n \times n}$, pertains to n criteria, while the second one, $T_D = [t_D^{ij}]_{m \times m}$, is devoted to m dimensions (clusters) from T_c (see Eq. (7)).

$$T_c = \begin{matrix} & \begin{matrix} D_1 & \dots & D_j & \dots & D_m \end{matrix} \\ \begin{matrix} D_1 \\ \vdots \\ D_i \\ \vdots \\ D_m \end{matrix} & \begin{bmatrix} c_{11} & \dots & c_{1j} & \dots & c_{1m} \\ \vdots & & \vdots & & \vdots \\ c_{i1} & \dots & c_{ij} & \dots & c_{im} \\ \vdots & & \vdots & & \vdots \\ c_{m1} & \dots & c_{mj} & \dots & c_{mm} \end{bmatrix} \end{matrix} \quad (6)$$

3.1.2. DANP for finding the influential weights in each criterion

Step 5: **Find the normalised total-influential matrix T_D^{nor} .** The total-influential matrix T_D needs to be normalised by dividing it by the following formula:

$$\begin{aligned} t_D^i &= \sum_{j=1}^m t_D^{ij} \\ T_D &= \begin{bmatrix} t_D^{11} & \dots & t_D^{1j} & \dots & t_D^{1m} \\ \vdots & & \vdots & & \vdots \\ t_D^{i1} & \dots & t_D^{ij} & \dots & t_D^{im} \\ \vdots & & \vdots & & \vdots \\ t_D^{m1} & \dots & t_D^{mj} & \dots & t_D^{mm} \end{bmatrix} \rightarrow \begin{aligned} &\sum_{j=1}^m t_D^{1j} = t_D^1 \\ &\vdots \\ &\sum_{j=1}^m t_D^{ij} = t_D^i \\ &\vdots \\ &\sum_{j=1}^m t_D^{mj} = t_D^m \end{aligned} \end{aligned} \quad (7)$$

Thus, the total-influential matrix can be normalised and presented as T_D^{nor} . Then, the sum of each row can be defined as $t_D^i = \sum_{j=1}^m t_D^{ij}$, where $i = 1, \dots, m$, and T_D can be normalised by the rows of sums by dividing the elements in each row by the sum of the row to obtain as in Eq. (7). Therefore, a total-influential matrix T_D can be normalised and represented as T_D^{nor} . $T_D^{nor} = [t_D^{ij}/t_D^i]_{m \times m}$, as in Eq. (8). Then, each row of the normalised T_D^{nor} can be summed to equal one, so that $\sum_{j=1}^m t_D^{nor,ij} = 1$.

$$T_D^{nor} = \begin{bmatrix} t_D^{11}/t_D^1 & \dots & t_D^{1j}/t_D^1 & \dots & t_D^{1m}/t_D^1 \\ \vdots & & \vdots & & \vdots \\ t_D^{i1}/t_D^i & \dots & t_D^{ij}/t_D^i & \dots & t_D^{im}/t_D^i \\ \vdots & & \vdots & & \vdots \\ t_D^{m1}/t_D^m & \dots & t_D^{mj}/t_D^m & \dots & t_D^{mm}/t_D^m \end{bmatrix} = \begin{bmatrix} t_D^{nor,11} & \dots & t_D^{nor,1j} & \dots & t_D^{nor,1m} \\ \vdots & & \vdots & & \vdots \\ t_D^{nor,i1} & \dots & t_D^{nor,ij} & \dots & t_D^{nor,im} \\ \vdots & & \vdots & & \vdots \\ t_D^{nor,m1} & \dots & t_D^{nor,mj} & \dots & t_D^{nor,mm} \end{bmatrix} \quad (8)$$

Step 6: **Find the normalised matrix T_c^{nor} by dimensions and clusters.** Normalise T_c with the total degrees of effect and influence of the dimensions and clusters to obtain T_c^{nor} , as shown in Eq. (9).

$$\begin{matrix}
 & D_1 & \dots & D_j & \dots & D_m \\
 & C_{11} \dots C_{1n_1} & \dots & C_{j1} \dots C_{jn_j} & \dots & C_{m1} \dots C_{mn_m} \\
 C_{11} & & & & & \\
 C_{12} & & & & & \\
 D_1 & \vdots & & & & \\
 C_{1n_1} & \left[\begin{array}{ccc} T_c^{nor_{11}} & \dots & T_c^{nor_{1j}} & \dots & T_c^{nor_{1m}} \\ \vdots & & \vdots & & \vdots \\ C_{i1} & & & & \\ C_{i2} & & & & \\ D_i & \vdots & T_c^{nor_{i1}} & \dots & T_c^{nor_{ij}} & \dots & T_c^{nor_{im}} \\ C_{in_i} & \vdots & & & & & \\ \vdots & & & & & & \\ C_{m1} & & & & & & \\ C_{m2} & & & & & & \\ D_m & \vdots & T_c^{nor_{m1}} & \dots & T_c^{nor_{mj}} & \dots & T_c^{nor_{mm}} \\ \vdots & & & & & & \\ C_{mn_m} & & & & & & \end{array} \right] & (9)
 \end{matrix}$$

Step 7: **Build an unweighted supermatrix W_c .** Then, the total-influential matrix is normalised into a supermatrix according to the interdependence between the relationships of the dimensions and clusters to obtain an unweighted supermatrix, W_c , as shown in Eq. (10).

$$\begin{matrix}
 & D_1 & \dots & D_j & \dots & D_m \\
 & C_{11} \dots C_{1n_1} & \dots & C_{m1} \dots C_{mn_m} & \dots & C_{j1} \dots C_{jn_j} \\
 C_{11} & & & & & \\
 \vdots & & & & & \\
 D_1 & \vdots & & & & \\
 C_{1n_1} & \left[\begin{array}{ccc} W_c^{11} & \dots & W_c^{1j} & \dots & W_c^{1m} \\ \vdots & & \vdots & & \vdots \\ C_{i1} & & & & \\ \vdots & & & & \\ D_i & \vdots & W_c^{ij} & \dots & W_c^{ij} & \dots & W_c^{mj} \\ C_{in_i} & \vdots & & & & & \\ \vdots & & & & & & \\ C_{m1} & & & & & & \\ D_m & \vdots & W_c^{m1} & \dots & W_c^{im} & \dots & W_c^{mm} \\ \vdots & & & & & & \\ C_{mn_m} & & & & & & \end{array} \right] & (10)
 \end{matrix}$$

Unweighted supermatrix W_c is the matrix transposed from T_c^{nor} (basic concept from the ANP by Saaty [70], but different from the traditional ANP). If a blank or 0 is shown in the matrix, this means that the dimensions and criteria are independent.

Step 8: **Find the influential weights of the DANP.** The total-influential matrix T_c needs to be normalised by dividing the dimension and cluster (Eq. (9)), so T_c is normalised by summarising the row by dimensions and clusters to obtain T_c^{nor} . An unweighted super-matrix W_c can be obtained by transposing T_c^{nor} , i.e., $W_c = (T_c^{nor})'$. Using (Eq. (11)), a weighted super-matrix W_c^* (improving the traditional ANP by using equal weights to make it appropriate for the real world) can be obtained by the product of T_D^{nor} and W_c , i.e., $W_c^* = T_D^{nor} W_c$ (Eq. (11)). This result demonstrates that these influential level values are the basis of normalisation to determine a weighted super-matrix.

$$W_c^* = T_D^{nor} W_c = \begin{bmatrix} t_D^{nor_{11}} \times W_c^{11} & \dots & t_D^{nor_{1j}} \times W_c^{1j} & \dots & t_D^{nor_{1m}} \times W_c^{1m} \\ \vdots & & \vdots & & \vdots \\ t_D^{nor_{ij}} \times W_c^{ij} & \dots & t_D^{nor_{ij}} \times W_c^{ij} & \dots & t_D^{nor_{mj}} \times W_c^{mj} \\ \vdots & & \vdots & & \vdots \\ t_D^{nor_{1m}} \times W_c^{1m} & \dots & t_D^{nor_{im}} \times W_c^{im} & \dots & t_D^{nor_{mm}} \times W_c^{mm} \end{bmatrix} \quad (11)$$

Step 9: **Obtain the DANP.** Limit the weighted super-matrix by raising it to a sufficiently large power φ until it converges and becomes a long-term stable super-matrix to obtain global priority vector, which defines the influential weights $w = (w_1, \dots, w_j, \dots, w_n)$ from $\lim_{\varphi \rightarrow \infty} (W_c^*)^\varphi$ for the criteria.

3.2. VIKOR method

The VIKOR method was developed for the multi-criteria optimisation of complex systems. It determines the compromise ranking list and the compromise solution, and the weight stability intervals for the preferred stability of the compromise solution can be obtained from the initial weights given by the AHP or ANP in the traditional method. This traditional method focuses on ranking and selection from a set of alternatives in cases of conflicting criteria. It introduces a multi-criteria ranking index based on the particular measure of “closeness” to the “ideal” solution [45,48,57,58,84]. This study focuses on improving this method to the aspiration level and knowing how to improve and create marketing strategies.

Assuming that each alternative is evaluated according to the function of each criterion, a compromise ranking can be obtained by comparing the measure of closeness to the ideal alternative in the traditional approach. The multi-criteria measure for compromise ranking is developed from the L_p – metric which plays an aggregating role in a compromise programming method [93,94].

The VIKOR was able to distinguish the three e-stores to determine their gaps. In a traditional VIKOR, the positive ideal point is set as the highest performance score among all alternatives (the larger is the better), i.e.; $f_j^+ = \max\{f_{kj} | k = 1, 2, \dots, K\}$ in this case. Likewise, the negative ideal point is set as the lowest performance score among all alternatives, when smaller is worst; i.e., $f_j^- = \min\{f_{kj} | k = 1, 2, \dots, K\}$ in this case. However, in this study, a new technique for improving the VIKOR method is proposed and described as follows. The alternatives are denoted $A_1, \dots, A_k, \dots, A_K$; w_j is set as the weight of the j – th criterion, expressing the relative influential weight of the criterion j by the DANP based on influential matrix T from the DEMATEL technique to make it applicable to the real-world situation, where $j = 1, 2, \dots, n$, and n is the number of criteria. The rating performance scores are normalised by the best value and the worst value for example, the scale performance scores from 0 (the worst value, $f_j^- = 0$) to 10 (the best value, called the aspiration level, $f_j^* = 10$), and the scores of the j -th criterion are denoted by f_{kj} for an alternative A_k as gap y_{kj} . The new VIKOR is more appropriate to the analysis of real-world situations. These models can be used to resolve other real business questions.

The new VIKOR method consists of the following:

Step 1: Finding the normalised gap.

$$y_{kj} = \left(|f_j^* - f_{kj}| \right) / \left(|f_j^* - f_j^-| \right) \quad (12)$$

where f_j^* is the best value (f_j^* is set as the aspiration level) and f_j^- is the worst value (f_j^- is set as the worst value or the so-called tolerable level) of all criterion functions $j = 1, 2, \dots, n$. These concepts are different from the traditional approach $f_j^* = \max_k f_{kj}$ and $f_j^- = \min_k f_{kj}$, in which higher-valued performance is better because they avoid “choose the best among

inferior choices, options, or alternatives (i.e., pick the best apple among a barrel of rotten apples)” problems. Thus, this performance definition differs from the traditional approach. It is more appropriate for the empirical business analysis of e-stores in the real world, to ascertain how the normalised scale of the gap, y_{kj} , can be reduced to zero (0) when the best value is set with no gap, the normalised scale of the gap y_{kj} is set to be one (1), and the worst value is set with the largest gap.

Step 2: Computing the gap for minimal and the maximal gap for priority improvement.

The general form of L_p -metric can be written as follows:

$$L_k^p = \left\{ \sum_{j=1}^n [w_j \times y_{kj}]^p \right\}^{1/p}, \quad 1 \leq p \leq \infty; k = 1, 2, \dots, K. \quad (13)$$

In addition to applying the above form of L_p - metric, the VIKOR method also uses $L_k^{p=1}$, which is shown as the average gap E_k in Eq. (14), and $L_k^{p=\infty}$, which is shown as the maximal gap Q_k , to improve the priority in Eq. (15).

$$E_k = L_k^{p=1} = \sum_{j=1}^n w_j \times y_{kj}, \quad \forall k \quad (14)$$

$$Q_k = L_k^{p=\infty} = \max_j \{y_{kj} | j = 1, 2, \dots, n\}, \quad \forall k \quad (15)$$

How can the smaller average gap E_k be better? The average gap (called the group utility) is emphasised in the case of $p = 1$. The importance of individual regrets or gaps (maximum regrets or gaps should be improved by their priority in total and by each p dimension) rises as the value of parameter p increases when $p = \infty$. The compromise solution $\min_k L_k^p$ will be chosen because its value is closest to the ideal or aspiration level. The usually applied expression $E_k^* = \min_k E_k$ is therefore changed because the best gap E_k^* is zero (i.e., $E_k^* = 0$), and the commonly utilised expression $E_k^- = \max_k E_k$ is changed because the worst value of E_k^- is one (i.e., $E_k^- = 1$). The expression $Q_k^* = \min_k Q_k$ is similarly changed because the best gap Q_k^* is zero (i.e., $Q_k^* = 0$), and the expression $Q_k^- = \max_k Q_k$ is changed because the worst value of Q_k^- is one (i.e., $Q_k^- = 1$).

Step 3: Obtaining the comprehensive indicator U_k

Based on the above concepts, the comprehensive indicator U_k of the compromise VIKOR can be written as Eq. (16) from the traditional form

$$U_k = \alpha(E_k - E_k^*) / (E_k^- - E_k^*) + (1 - \alpha)(Q_k - Q_k^*) / (Q_k^- - Q_k^*) \quad (16)$$

Then, based on the concept above, the best situation, when $E_k^* = 0$ and $Q_k^* = 0$, and the worst situation, when $E_k^- = 1$ and $Q_k^- = 1$, can be rewritten as follows:

$$U_k = \alpha E_k + (1 - \alpha) Q_k \quad (17)$$

This paper seeks to combine the influential weights of the DANP with the VIKOR method to determine how to minimise the average gap (or regret) and prioritise improvement in the maximum gap overall and in each dimension based on the INRM by the DEMATEL technique. Thus, this study focuses on how to improve and reduce the performance gaps to achieve the aspiration level based on INRM.

4. Empirical case study of real e-stores

Because e-store commerce is growing fast, and the Internet is not limited by national boundaries, the competitive business environment makes it essential for e-store managers to know how to manage their e-stores and attract more consumers to browse, pur-

chase, and repurchase. Previous papers seldom address e-store management and marketing strategy problems.

We used two different questionnaires in this research. The first questionnaire for influential relationships among criteria was distributed to eight frequent shoppers who are e-store **experts** (the eight experts' group consensus of significant confidence in the questionnaires, which is 95.11%, is shown in Tables A1 and A2 of Appendix A). The questionnaires for influential relationships among dimensions and criteria were conducted on the basis of a face-to-face pairwise comparison to evaluate the effect and influence of the criteria, using a five-point scale ranging from four (extremely influential) to zero (completely non-influential).

The second questionnaire was the e-stores' performance questionnaire, which was distributed to 1,018 consumers who often purchase products from the three chosen e-stores (The reliability is 93.9%, and the validity is 92.9% (KMO test)). These questionnaires used an eleven-point scale ranging from zero (very poor performance) to ten (excellent performance), i.e., very dissatisfied or very bad $\leftarrow 0, 1, 2, \dots, 9, 10 \rightarrow$ very satisfied or very good. It is hoped that this research can help e-store managers to improve and manage their stores more effectively to satisfy customers and promote higher rates of repurchase. The goal is to provide marketing strategies for managers to build an effective business by reducing or eradicating the gaps in e-store service and achieving aspiration levels.

4.1. Description of problem

In the e-era, the Internet has proved to be a particularly powerful channel for providing information to customers because it reduces buyers' costs and the time spent searching for the right product. Because e-stores are able to respond rapidly to changes in the marketplace, many prestigious companies have incorporated an e-store as a means of attracting customers who find it convenient to shop from their homes or places other than physical brick-and-mortar stores. Indeed, e-stores provide a diffuse and ubiquitous network of points of access. They are open 24 h a day and seven days a week, so customers can shop anywhere and at any time. In today's fiercely competitive electronic marketplace, e-stores are more anxious than ever to create a long-lasting relationship with their customers. Although all firms have the ability to establish and manage their own e-store sales channels, not all of them can successfully operate an e-commerce business. Therefore, e-store managers must know how to turn “lookers” into “buyers” and “purchases” into “repurchases.” A well-established brand name particularly helps to build trust with customers, which is essential for online sales [16].

The emergence of the e-store has led many organisations to rethink their business strategies to remain competitive. E-stores provide companies with the opportunity to reach new markets, new customers, and new information, improve customer services, distribute products more quickly, communicate more effectively, and increase profitability [2,25]. In other words, they provide companies with many competitive advantages. An effective e-store manager uses the Internet to enhance customer relations management (CRM) and attract potential customers [6]. This paper seeks to provide recommendations to the managers of three of the most popular e-store websites in Taiwan (i.e., Yahoo, PChome, and Books) that can help to improve their business and marketing strategy, increase the number of customers, increase the volume of business, and maximise profits.

4.2. Measuring the relationship among dimensions and criteria to build an INRM

The DEMATEL technique is used to model influential relationships among dimensions and criteria and to establish an INRM

for those dimensions and criteria using pair-wise comparisons (see Fig. 2). This technique can help to determine the levels of needs to improve them.

The shopping experts were asked to determine the influence of the relationships among the criteria. The average initial direct-relation 14×14 matrix G , obtained using pair-wise comparisons in terms of influences and directions between criteria, is shown in Table 2.

As matrix G shows, the normalised direct-relation matrix X is calculated using Eqs. (1) and (2), as shown in Table 3. Then, the total-influential matrix T_c can be derived using Eqs. (3) and (7), as shown in Tables 4 and 5. Furthermore, by using Eqs. (4) and (5), the total-influence given and received according to each dimension and criterion can be summarised, as shown in Table 6. Thus, the INRM of the DEMATEL technique can be obtained as shown in Fig. 2 by using Table 6.

4.3. Influential weights of criteria in e-store management

Having determined the relationship structure of e-store business criteria, the DANP method was applied to obtain the influential weights of the criteria. Initially, the influence of the relationship among the criteria was compared based on the INRM. An unweighted supermatrix W_c can be obtained by transposing the normalised matrix T_c^{nor} , i.e., $W_c = (T_c^{nor})'$, as shown in Table 7.

The influential weights W_c^* of DANP based on Eqs. (8)–(11) are shown in Table 8.

The influential weights of DANP can be obtained by limiting the power of the weighted super-matrix ($\lim_{\phi \rightarrow \infty} (W_c^*)^\phi$) until it reaches a steady-state (see Table 9).

4.4. Using the method to evaluate e-store management performance and gaps

In Taiwan, 1018 customers who use e-stores were asked to evaluate their level of satisfaction with each criterion. The DANP method was used to obtain the influential weights of the dimensions and criteria to apply to a real case. The global influential weights and local influential weights of the dimensions and criteria were obtained based on the DANP technique (see Table 10), which

was followed by combining the DANP with the VIKOR method to obtain the average performance scores (satisfaction) of Yahoo (A_1), PChome (A_2), and Books (A_3), which were 7.538, 7.470, and 7.601, respectively (as shown in Table 10).

4.5. Results and discussions

This study has three results. First, in the INRM, it can be easily understood from Fig 2 and Table 6 that five dimensions influence each other. For example, dimension A affects dimensions E, D, B, and C ($A \rightarrow \{E D B C\}$); dimension E affects dimensions D, B, and C ($E \rightarrow \{D B C\}$); dimension D affects dimensions B and C ($D \rightarrow \{B C\}$); and dimension B affects dimension C ($B \rightarrow \{C\}$). Understanding these influential relationships will enable managers to make decisions; for example, they should first improve A (need recognition), followed by E (post-purchase behaviour), D (choice/purchase), B (information search), and C (evaluation of alternatives).

Fig. 2 and Table 6 demonstrate that criterion e_1 affects criteria e_2 and e_3 ($e_1 \rightarrow \{e_2 e_3\}$), and criterion e_2 affects criterion e_3 ($e_2 \rightarrow \{e_3\}$). In addition, criterion d_1 affects criteria d_4 , d_3 , and d_2 ($d_1 \rightarrow \{d_4 d_3 d_2\}$), criterion d_4 affects criteria d_3 and d_2 ($d_4 \rightarrow \{d_3 d_2\}$), and criterion d_3 affects criterion d_2 ($d_3 \rightarrow \{d_2\}$). Criterion b_2 affects criteria b_3 and b_1 ($b_2 \rightarrow \{b_3 b_1\}$), and criterion b_3 affects criterion b_1 ($b_3 \rightarrow \{b_1\}$). Criterion c_2 affects criteria c_3 and c_1 ($c_2 \rightarrow \{c_3 c_1\}$), and criterion c_3 affects criterion c_1 ($c_3 \rightarrow \{c_1\}$).

These e-stores must improve their business strategies to meet consumers' needs, generate more purchases and repurchases, and devise the best marketing strategies with the most effective and efficient ways to achieve customer satisfaction. The e-store ranking further indicates the dimensions that need to be most improved: need recognition > post-purchase behaviour > choice/purchase > information search > evaluation of alternatives. This study demonstrates that the impact of need recognition and post-purchase on the intention to repurchase consists of product availability, order tracking, on-time delivery, and expectations met, supporting the results obtained by Gauri et al. [31]. Thus, this study has proved that DEMATEL can correctly indicate the effect of e-store criteria and identify those that need to be improved first.

Based on the result above, we can establish marketing strategies by using advertisements and light products to persuade customers

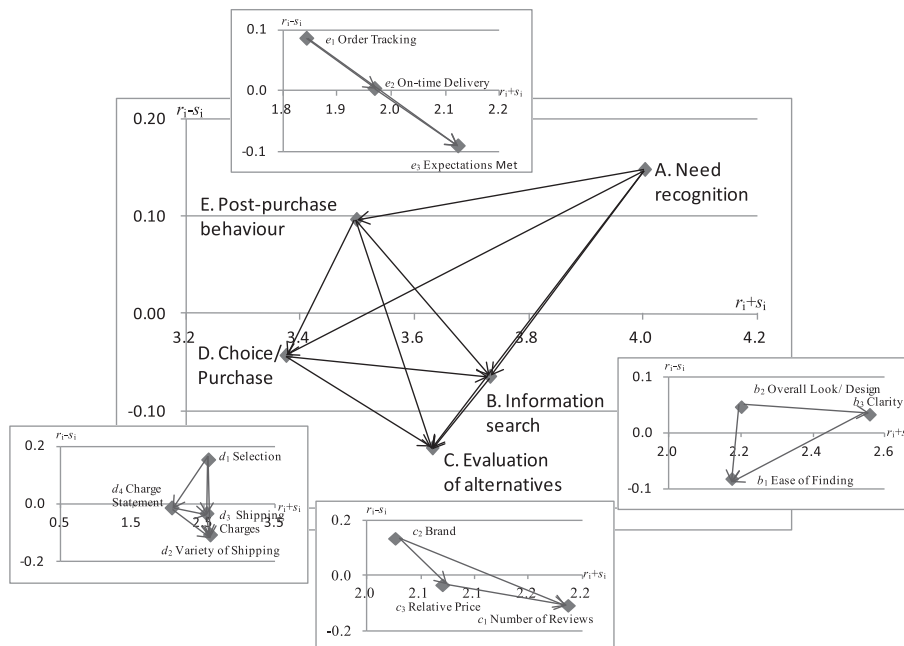


Fig. 2. Influential network relations map (INRM).

Table 2
Initial influential matrix G.

Dimensions/criteria (G)		A. Need recognition			B. Information search			C. Alternatives evaluation			D. Choice/purchase				E. Post-purchase behaviour			Total
		<i>a</i> ₁	<i>b</i> ₁	<i>b</i> ₂	<i>b</i> ₃	<i>c</i> ₁	<i>c</i> ₂	<i>c</i> ₃	<i>d</i> ₁	<i>d</i> ₂	<i>d</i> ₃	<i>d</i> ₄	<i>e</i> ₁	<i>e</i> ₂	<i>e</i> ₃			
A. Need recognition	<i>a</i> ₁ Product availability	0.000	2.125	1.875	3.000	3.375	1.250	3.250	2.125	2.250	2.375	2.000	1.375	1.875	2.875	29.750		
B. Information search	<i>b</i> ₁ Ease of finding	1.875	0.000	2.625	2.625	1.875	1.375	1.375	2.500	1.375	1.125	1.500	1.375	1.250	2.000	22.875		
	<i>b</i> ₂ Overall look/design	2.000	2.750	0.000	3.375	1.875	1.375	1.500	2.875	1.500	1.125	1.500	1.500	1.250	1.625	24.250		
	<i>b</i> ₃ Clarity	3.125	3.625	3.125	0.000	1.875	1.375	1.750	3.250	2.000	1.500	1.625	1.375	1.250	2.625	28.500		
C. Evaluation of alternatives	<i>c</i> ₁ Number of reviews	2.125	1.875	1.625	1.875	0.000	2.750	2.250	1.500	1.125	1.500	1.250	1.250	1.500	2.750	23.375		
	<i>c</i> ₂ Brand	1.250	1.750	2.125	2.125	2.875	0.000	2.000	1.750	1.750	1.750	2.000	1.750	1.875	2.125	25.125		
	<i>c</i> ₃ Relative price	3.125	1.250	1.250	2.000	2.500	1.375	0.000	1.500	1.375	2.500	1.250	1.250	1.500	2.625	23.500		
D. Choice/ Purchase	<i>d</i> ₁ Selection	2.000	3.000	2.750	3.000	2.000	1.625	1.750	0.000	2.125	1.625	1.750	1.125	1.375	1.625	25.750		
	<i>d</i> ₂ Variety of shipping	1.750	1.250	1.500	1.625	1.750	1.625	2.000	1.625	0.000	2.750	1.875	1.750	2.250	1.625	23.375		
	<i>d</i> ₃ Shipping charges	2.000	1.125	1.250	1.625	1.500	2.250	3.000	1.250	2.875	0.000	1.375	1.875	2.125	1.625	23.875		
	<i>d</i> ₄ Charge statement	1.750	1.375	1.125	1.625	1.250	1.625	1.500	1.500	1.625	1.625	0.000	1.375	1.125	1.375	18.875		
E. Post-purchase behaviour	<i>e</i> ₁ Order tracking	1.250	1.125	1.375	1.500	1.625	1.625	1.250	1.250	3.125	2.250	1.250	0.000	3.500	2.125	23.250		
	<i>e</i> ₂ On-time delivery	1.500	1.250	1.125	1.500	2.250	2.375	1.750	1.375	3.125	2.750	1.000	2.875	0.000	1.875	24.750		
	<i>e</i> ₃ Met expectations	3.000	2.000	2.000	3.125	3.000	2.500	2.500	1.500	1.375	1.625	0.875	1.500	1.750	0.000	26.750		
Total		26.750	24.500	23.750	29.000	27.750	23.125	25.875	24.000	25.625	24.500	19.250	20.375	22.625	26.875	-		

Table 3
Normalised direct-relation X.

Dimensions/criteria (X)		A. Need recognition			B. Information search			C. Alternatives evaluation			D. Choice/purchase				E. Post-purchase behaviour		
		<i>a</i> ₁	<i>b</i> ₁	<i>b</i> ₂	<i>b</i> ₃	<i>c</i> ₁	<i>c</i> ₂	<i>c</i> ₃	<i>d</i> ₁	<i>d</i> ₂	<i>d</i> ₃	<i>d</i> ₄	<i>e</i> ₁	<i>e</i> ₂	<i>e</i> ₃		
<i>a</i> ₁	Product availability	0.000	0.071	0.063	0.101	0.113	0.042	0.109	0.071	0.076	0.080	0.067	0.046	0.063	0.097		
<i>b</i> ₁	Ease of finding	0.063	0.000	0.088	0.088	0.063	0.046	0.046	0.084	0.046	0.038	0.050	0.046	0.042	0.067		
<i>b</i> ₂	Overall look/design	0.067	0.092	0.000	0.113	0.063	0.046	0.050	0.097	0.050	0.038	0.050	0.050	0.042	0.055		
<i>b</i> ₃	Clarity	0.105	0.122	0.105	0.000	0.063	0.046	0.059	0.109	0.067	0.050	0.055	0.046	0.042	0.088		
<i>c</i> ₁	Number of reviews	0.071	0.063	0.055	0.063	0.000	0.092	0.076	0.050	0.038	0.050	0.042	0.042	0.050	0.092		
<i>c</i> ₂	Brand	0.042	0.059	0.071	0.071	0.097	0.000	0.067	0.059	0.059	0.059	0.067	0.059	0.063	0.071		
<i>c</i> ₃	Relative price	0.105	0.042	0.042	0.067	0.084	0.046	0.000	0.050	0.046	0.084	0.042	0.042	0.050	0.088		
<i>d</i> ₁	Selection	0.067	0.101	0.092	0.101	0.067	0.055	0.059	0.000	0.071	0.055	0.059	0.038	0.046	0.055		
<i>d</i> ₂	Variety of shipping	0.059	0.042	0.050	0.055	0.059	0.055	0.067	0.055	0.000	0.092	0.063	0.059	0.076	0.055		
<i>d</i> ₃	Shipping charges	0.067	0.038	0.042	0.055	0.050	0.076	0.101	0.042	0.097	0.000	0.046	0.063	0.071	0.055		
<i>d</i> ₄	Charge statement	0.059	0.046	0.038	0.055	0.042	0.055	0.050	0.050	0.055	0.055	0.000	0.046	0.038	0.046		
<i>e</i> ₁	Order tracking	0.042	0.038	0.046	0.050	0.055	0.055	0.042	0.042	0.105	0.076	0.042	0.000	0.118	0.071		
<i>e</i> ₂	On-time delivery	0.050	0.042	0.038	0.050	0.076	0.080	0.059	0.046	0.105	0.092	0.034	0.097	0.000	0.063		
<i>e</i> ₃	Met expectations	0.101	0.067	0.067	0.105	0.101	0.084	0.084	0.050	0.046	0.055	0.029	0.050	0.059	0.000		

Table 4
Total-influential dimensions matrix T_D .

Dimensions	A. Need recognition	B. Information search	C. Evaluation of alternatives	D. Choice/purchase	E. Post-purchase behaviour	r_i
A. Need recognition	0.389	0.443	0.448	0.400	0.395	2.075
B. Information search	0.406	0.385	0.365	0.343	0.334	1.833
C. Alternatives evaluation	0.385	0.360	0.349	0.323	0.330	1.746
D. Choice/purchase	0.361	0.345	0.344	0.304	0.311	1.665
E. Post-purchase behaviour	0.386	0.365	0.377	0.339	0.330	1.797
s_i	1.927	1.898	1.884	1.708	1.700	–

Table 5
Total-influential criteria matrix T_C .

Criteria	a_1	b_1	b_2	b_3	c_1	c_2	c_3	d_1	d_2	d_3	d_4	e_1	e_2	e_3	r_i
a_1 Product availability	0.389	0.422	0.403	0.505	0.500	0.372	0.472	0.412	0.427	0.421	0.339	0.333	0.377	0.476	0.389
b_1 Ease of finding	0.363	0.283	0.354	0.408	0.370	0.303	0.335	0.353	0.324	0.307	0.266	0.270	0.289	0.365	1.046
b_2 Overall look/design	0.385	0.385	0.290	0.448	0.388	0.317	0.355	0.380	0.344	0.323	0.279	0.286	0.303	0.373	1.123
b_3 Clarity	0.470	0.459	0.432	0.404	0.443	0.361	0.414	0.437	0.406	0.380	0.321	0.322	0.346	0.453	1.294
c_1 Number of reviews	0.377	0.345	0.328	0.391	0.321	0.350	0.370	0.325	0.323	0.325	0.263	0.272	0.303	0.395	1.041
c_2 Brand	0.367	0.356	0.357	0.415	0.424	0.281	0.376	0.348	0.358	0.349	0.297	0.301	0.329	0.392	1.082
c_3 Relative price	0.411	0.328	0.318	0.398	0.401	0.313	0.305	0.327	0.335	0.360	0.265	0.275	0.307	0.395	1.019
d_1 Selection	0.401	0.407	0.388	0.455	0.409	0.340	0.379	0.306	0.378	0.353	0.299	0.289	0.321	0.389	1.336
d_2 Variety of shipping	0.361	0.320	0.318	0.377	0.370	0.316	0.359	0.324	0.287	0.362	0.279	0.287	0.326	0.357	1.252
d_3 Shipping charges	0.375	0.322	0.316	0.384	0.370	0.339	0.395	0.319	0.382	0.285	0.269	0.296	0.328	0.365	1.255
d_4 Charge statement	0.307	0.275	0.260	0.320	0.299	0.267	0.290	0.273	0.286	0.279	0.181	0.233	0.245	0.295	1.018
e_1 Order tracking	0.343	0.313	0.312	0.370	0.364	0.316	0.334	0.310	0.383	0.349	0.258	0.233	0.363	0.369	0.965
e_2 On-time delivery	0.368	0.333	0.321	0.389	0.401	0.353	0.367	0.330	0.399	0.378	0.265	0.334	0.272	0.381	0.987
e_3 Met expectations	0.448	0.391	0.380	0.476	0.459	0.381	0.420	0.367	0.371	0.370	0.283	0.313	0.348	0.357	1.017
s_i	0.389	1.127	1.076	1.260	1.146	0.945	1.051	1.222	1.332	1.280	1.028	0.879	0.983	1.107	

Table 6
Sum of influences given and received on dimensions and criteria.

Dimensions/criteria	r_i	s_i	$r_i + s_i$	$r_i - s_i$
A. Need recognition	2.075	1.927	4.002	0.148
a_1 Product availability	0.389	0.389	0.778	0.000
B. Information search	1.833	1.898	3.731	−0.064
b_1 Ease of finding	1.046	1.127	2.173	−0.081
b_2 Overall look/design	1.123	1.076	2.199	0.047
b_3 Clarity	1.294	1.260	2.555	0.034
C. Evaluation of alternatives	1.746	1.884	3.630	−0.138
c_1 Number of reviews	1.041	1.146	2.187	−0.105
c_2 Brand	1.082	0.945	2.026	0.137
c_3 Relative price	1.019	1.051	2.070	−0.031
D. Choice/purchase	1.665	1.708	3.374	−0.043
d_1 Selection	1.336	1.222	2.558	0.114
d_2 Variety of shipping	1.252	1.332	2.584	−0.080
d_3 Shipping charges	1.255	1.280	2.535	−0.025
d_4 Charge statement	1.018	1.028	2.047	−0.010
E. Post-purchase behaviour	1.797	1.700	3.497	0.097
e_1 Order tracking	0.965	0.879	1.844	0.086
e_2 On-time delivery	0.987	0.983	1.970	0.004
e_3 Met expectations	1.017	1.107	2.123	−0.090

to buy products to improve the dimension “need recognition (A)”. For the dimension “post-purchase behaviour (E)”, e-stores can create high-quality post-sales service programmes and offer fast delivery of products to improve the “order tracking (e_1)” and “on-time delivery (e_2)” criteria, and they can provide complete packaging, add service speed, give reassuring communication after the purchase, offer guarantees, and implement liberal returns policies to improve “expectations met (e_3)”. To improve the dimension of “choice/purchase (D)”, e-stores can provide an assortment of merchandise, an interface that is easy to access and navigate, and a satisfactory number of alternatives to improve network crowding; they can offer various methods of payment and provide a clean bill of sale to improve “charge statement (d_4)”; clear shipping prices can improve “shipping charges (d_3)”; and convenience and easy transactions can improve the “variety of shipping (d_2)”. In

the “information search (B)” dimension, e-stores can enhance the appearance and design of their websites, use attractive animated graphics, provide the expected value of additional information, and offer a variety of categories to improve the “overall look and design (b_2)”, “clarity (b_3)”, and “ease of finding (b_1)”. To facilitate “evaluation of alternatives (C)”, e-stores can provide former customers’ experience, namely word-of-mouth (chat rooms and blog) and services offered to improve the image of the “brand (c_2)”; they can display other e-store references or relative prices to improve “relative price (c_3)”; and they can correct any unfavourable perception to improve the “number of reviews (c_1)” (see Fig. 2).

In addition to the summary above, new e-store managers can refer to the INRM of the DEMATEL technique to prioritise the improvement of dimensions and criteria and creating marketing strategies for their e-store business.

The second results were influential weights. As seen in Table 9, the highest relative weights were “clarity b_3 ” and “number of reviews c_1 ”, assessed at 0.084 and 0.080, respectively. This result shows that an e-store’s “clarity” of information about products and customer’s rating of the e-store as having a good “number of reviews” have the greatest relative influence of all criteria. Thus, it is extremely important to deliver clear and careful information to customers on an e-store website because this parameter can contribute to positive reviews. The lowest priority was “charge statement d_4 (0.056)”. This result shows that an e-store’s clear display of price, quantity, shipping fee, and total fee makes “charge statement” the least influential criterion. “Need recognition (A)” was the most influential dimension within an e-store business. Fig. 2 and Table 9 illustrate the priority of criterion improvement from top to bottom, where improvement of the most influential criteria would provide the best effect. The priority of dimensions and criteria for improvement should be considered in entire systems (based on Fig. 2) to reduce gaps and meet customers’ needs. It is possible that improving different criteria will strongly influence the results directly and indirectly.

The third result (see Table 10), which ranked three e-stores’ performances, determined that Books surpassed Yahoo, which

Table 7
Unweighted supermatrix W_c .

Unweighted		a_1	b_1	b_2	b_3	c_1	c_2	c_3	d_1	d_2	d_3	d_4	e_1	e_2	e_3
A. Need recognition	a_1 Product availability	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
B. Information search	b_1 Ease of finding	0.317	0.271	0.343	0.354	0.324	0.316	0.314	0.325	0.315	0.315	0.321	0.315	0.319	0.314
	b_2 Overall look/design	0.303	0.339	0.258	0.334	0.309	0.316	0.305	0.310	0.313	0.310	0.304	0.314	0.308	0.305
	b_3 Clarity	0.380	0.390	0.399	0.312	0.368	0.368	0.381	0.364	0.372	0.376	0.374	0.372	0.373	0.382
C. Evaluation of alternatives	c_1 Number of reviews	0.372	0.368	0.366	0.364	0.308	0.392	0.394	0.362	0.354	0.335	0.349	0.359	0.358	0.364
	c_2 Brand	0.277	0.300	0.299	0.297	0.337	0.260	0.307	0.301	0.302	0.307	0.312	0.311	0.315	0.302
	c_3 Relative price	0.351	0.332	0.335	0.340	0.355	0.348	0.299	0.336	0.344	0.358	0.339	0.330	0.327	0.333
D. Choice/purchase	d_1 Selection	0.258	0.282	0.287	0.283	0.263	0.257	0.254	0.229	0.259	0.254	0.268	0.239	0.240	0.264
	d_2 Variety of shipping	0.267	0.259	0.259	0.263	0.261	0.265	0.260	0.283	0.229	0.304	0.281	0.295	0.291	0.267
	d_3 Shipping charges	0.263	0.246	0.243	0.246	0.263	0.258	0.280	0.264	0.289	0.227	0.274	0.268	0.276	0.266
	d_4 Charge statement	0.212	0.213	0.210	0.208	0.212	0.220	0.206	0.224	0.223	0.215	0.178	0.199	0.193	0.204
E. Post-purchase behaviour	e_1 Order tracking	0.281	0.292	0.298	0.287	0.281	0.294	0.281	0.289	0.296	0.299	0.301	0.241	0.338	0.307
	e_2 On-time delivery	0.318	0.313	0.315	0.309	0.312	0.322	0.314	0.321	0.336	0.331	0.317	0.377	0.276	0.342
	e_3 Met expectations	0.401	0.395	0.387	0.404	0.407	0.384	0.405	0.389	0.368	0.369	0.382	0.382	0.386	0.351

Table 8
The weighted supermatrix W_c^* , produced by weighting the unweighted supermatrix W_c .

Weighted		a_1	b_1	b_2	b_3	c_1	c_2	c_3	d_1	d_2	d_3	d_4	e_1	e_2	e_3
A. Need recognition	a_1 Product availability	0.067	0.081	0.081	0.081	0.080	0.080	0.080	0.079	0.079	0.079	0.079	0.078	0.078	0.078
B. Information search	b_1 Ease of finding	0.072	0.062	0.079	0.081	0.073	0.071	0.071	0.074	0.071	0.071	0.072	0.070	0.070	0.069
	b_2 Overall look/design	0.069	0.078	0.059	0.077	0.069	0.071	0.069	0.070	0.071	0.070	0.069	0.069	0.068	0.068
	b_3 Clarity	0.086	0.089	0.091	0.071	0.083	0.083	0.086	0.082	0.084	0.085	0.084	0.082	0.082	0.084
C. Evaluation of alternatives	c_1 Number of reviews	0.086	0.080	0.080	0.079	0.067	0.086	0.086	0.082	0.080	0.076	0.079	0.082	0.082	0.083
	c_2 Brand	0.064	0.066	0.065	0.065	0.074	0.057	0.067	0.068	0.068	0.069	0.071	0.071	0.072	0.069
	c_3 Relative price	0.081	0.072	0.073	0.074	0.078	0.076	0.066	0.076	0.078	0.081	0.077	0.075	0.075	0.076
D. Choice/purchase	d_1 Selection	0.070	0.077	0.078	0.077	0.071	0.069	0.068	0.061	0.069	0.067	0.071	0.065	0.066	0.072
	d_2 Variety of shipping	0.073	0.071	0.071	0.072	0.070	0.071	0.070	0.075	0.061	0.081	0.074	0.081	0.079	0.073
	d_3 Shipping charges	0.072	0.067	0.067	0.067	0.071	0.069	0.075	0.070	0.077	0.060	0.073	0.073	0.075	0.073
	d_4 Charge statement	0.058	0.058	0.057	0.057	0.057	0.059	0.055	0.059	0.059	0.057	0.047	0.054	0.053	0.056
E. Post-purchase behaviour	e_1 Order tracking	0.057	0.058	0.059	0.057	0.058	0.061	0.058	0.059	0.060	0.061	0.061	0.048	0.068	0.061
	e_2 On-time delivery	0.064	0.062	0.063	0.062	0.065	0.067	0.065	0.065	0.069	0.068	0.065	0.075	0.055	0.068
	e_3 Met expectations	0.081	0.079	0.077	0.080	0.084	0.080	0.084	0.080	0.075	0.075	0.078	0.077	0.077	0.070

Table 9
Influential weights by stable matrix of DANP when power $\lim_{\rho \rightarrow \infty} (W_c^*)^\rho$.

Criteria	a_1	b_1	b_2	b_3	c_1	c_2	c_3	d_1	d_2	d_3	d_4	e_1	e_2	e_3
Weights (DANP)	0.079	0.072	0.070	0.084	0.080	0.067	0.076	0.070	0.073	0.071	0.056	0.059	0.065	0.078

surpassed PChome (Books (A_3)) > Yahoo (A_1) > PChome (A_2)). The integration of the performance index scores of Yahoo in the DANP further demonstrated that the dimension of the “need recognition” gap is 0.279 and the gap for the “Shipping Charges” criterion is 0.290 constituting the largest gaps, which the Yahoo e-store should improve as a priority. The integration of the performance index scores of PChome in the DANP showed that the gap of the “need recognition” dimension is 0.274, and the gap of the “Overall Look/Design” criterion is 0.289 constituting the largest gaps, which the PChome e-store should improve as a priority. The integration of the performance index scores of Books in the DANP showed that gap of the “need recognition” dimension is 0.296 and the gap of the “Relative Price” criterion is 0.307 consti-

tuting the largest gaps, which the Books e-store should improve as a priority. Thus, the priority for Yahoo, PChome, and Books is to enhance their product variety to satisfy their customers’ needs.

The e-store strategies were defined by using the data in Table 10 (shown in Table 11). This process demonstrated that the priorities of each e-store’s strategy were dissimilar. The results indicated that Yahoo, PChome, and Books needed to enhance their product availability. Therefore, Yahoo, PChome, and Books should all strengthen their efforts to develop and comply with their customers’ need for products and goods or extend their products and goods category to satisfy their customers. Additionally, providing the best service to customers at the post-purchase stage is an

Table 10
Performance values combined with the influential weights of the criteria according to the DANP.

Alternatives			Yahoo (A ₁)		Pchome (A ₂)		Books (A ₃)		
	Local weight (based on DANP)	Global weight (DANP)	aspiration value	Performance (A ₁)	Gap (VIKOR)	Performance (A ₂)	Gap (VIKOR)	Performance (A ₃)	Gap (VIKOR)
A.Need recognition	0.079			7.212	(0.279)	7.261	(0.274)	7.040	(0.296)
<i>a</i> ₁ Product Availability	1.000	0.079	10.000	7.212	(0.279)	7.261	(0.274)	7.040	(0.296)
B.Information search	0.226			7.336	(0.266)	7.341	(0.266)	7.605	(0.239)
<i>b</i> ₁ Ease of Finding	0.318	0.072	10.000	7.586	(0.241)	7.481	(0.252)	7.484	(0.252)
<i>b</i> ₂ Overall Look/ Design	0.310	0.070	10.000	7.133	(0.287)	7.108	(0.289)	7.668	(0.233)
<i>b</i> ₃ Clarity	0.372	0.084	10.000	7.292	(0.271)	7.417	(0.258)	7.656	(0.234)
C.Evaluation of alternatives	0.223			7.584	(0.242)	7.510	(0.249)	7.491	(0.251)
<i>c</i> ₁ Number of Reviews	0.359	0.080	10.000	7.735	(0.226)	7.511	(0.249)	7.508	(0.249)
<i>c</i> ₂ Brand	0.300	0.067	10.000	7.644	(0.236)	7.628	(0.237)	8.114	(0.189)
<i>c</i> ₃ Relative Price	0.341	0.076	10.000	7.373	(0.263)	7.405	(0.259)	6.927	(0.307)
D.Choice/ Purchase	0.270			7.759	(0.224)	7.550	(0.245)	7.710	(0.229)
<i>d</i> ₁ Selection	0.259	0.070	10.000	7.983	(0.202)	7.687	(0.231)	7.892	(0.211)
<i>d</i> ₂ Variety of Shipping	0.270	0.073	10.000	7.776	(0.222)	7.511	(0.249)	7.666	(0.233)
<i>d</i> ₃ Shipping Charges	0.263	0.071	10.000	7.104	(0.290)	7.188	(0.281)	7.255	(0.274)
<i>d</i> ₄ Charge Statement	0.208	0.056	10.000	8.285	(0.171)	7.889	(0.211)	8.115	(0.188)
E.Post-purchase behaviour	0.202			7.544	(0.246)	7.546	(0.245)	7.791	(0.221)
<i>e</i> ₁ Order Tracking	0.292	0.059	10.000	7.605	(0.240)	7.484	(0.252)	7.626	(0.237)
<i>e</i> ₂ On-time Delivery	0.322	0.065	10.000	7.610	(0.239)	7.582	(0.242)	7.746	(0.225)
<i>e</i> ₃ Met Expectations	0.386	0.078	10.000	7.442	(0.256)	7.564	(0.244)	7.953	(0.205)
Total	1.000	1.000	-	7.538(2)	0.246(2)	7.470(3)	0.253(3)	7.601(1)	0.240(1)

essential dimension because this consideration primarily determines the consumers' choice of e-store.

According to the DANP based on the basic concept of ANP, the data in Table 9 were designed and obtained to calculate a weighted and unweighted super-matrix to determine the influential weights based on the total-influential normalised matrix. Table 10 shows the e-store criteria weighted super-matrix indices, as well as the performance gaps of Books, Yahoo, and Pchome. Each row represents the weight of each criterion (Table 9). Therefore, in this paper, based on the results previously provided, the influential weights of the criteria and index were created using the DEMATEL technique and the DANP in conjunction with VIKOR for performance evaluation.

The e-store strategy, which emphasises the e-store business goal of satisfying customers' needs, is shown in Table 11. The results of this research indicate that no e-store business strategy is the same; consequently, managers of e-stores must use this method to determine their customers' wants and needs to define the gap and improve it to achieve the ideal solution or aspiration level.

5. Conclusion and remarks

This study can help e-store managers to reflect on the improvement of marketing strategies, service re-engineering, and management redesign. The influential weight questionnaire from experts and the performance questionnaires from 1,018 e-store consumers are more relevant than other traditional evaluation techniques in the real world.

E-stores can offer products and services at a reduced cost at any time and in any place, making good e-store management essential in the business field. This research used the DEMATEL technique in conjunction with a DANP to produce an INRM and influential weights of criteria, and it used a VIKOR to ascertain the gaps in the three chosen e-stores and discover how to improve them. The traditional e-store approach is to rank the alternatives and only use the best, whereas this current study not only selects the best but also analyses which gaps in the dimensions and criteria should be improved first. An important topic for future research is how to formulate strategies to improve and reduce the gaps to

Table 11
E-stores' priority strategies for improvement.

e-Store	Strategies
Yahoo	The priority index for improving the dimensions includes need recognition, information search, post-purchase behaviour, evaluation of alternatives, and choice/purchase The priority index for improving the criteria includes shipping charges, overall look and design, product availability, clarity, relative price, expectations met, ease of finding, order tracking, on-time delivery, brand, number of reviews, variety of shipping, selection, and charge statement
Pchome	The priority index for improving the dimensions includes need recognition, information search, the evaluation of alternatives, post-purchase behaviour, and choice/purchase The priority index for improving the criteria includes overall look and design, shipping charges, product availability, relative price, clarity, ease of finding, order tracking, number of reviews, variety of shipping, expectations met, on-time delivery, brand, selection, and charge statement
Books	The priority index for improving the dimensions includes need recognition, the evaluation of alternatives, information search, choice/purchase, and post-purchase behaviour The priority index for improving the criteria includes relative price, product availability, shipping charges, ease of finding, number of reviews, order tracking, clarity, variety of shipping, overall look and design, on-time delivery, selection, met expectation, brand, and charge statement

Table A1
Group consensuses of the seven respondents on the degree of influence among the criteria (unit:%).

Criteria	a_1	b_1	b_2	b_3	c_1	c_2	c_3	d_1	d_2	d_3	d_4	e_1	e_2	e_3
a_1	0.000	2.286	2.000	3.286	3.286	1.286	3.143	2.286	2.429	2.571	2.143	1.429	2.000	2.714
b_1	2.000	0.000	2.857	2.714	1.857	1.429	1.429	2.286	1.429	1.143	1.571	1.429	1.286	2.143
b_2	2.143	2.714	0.000	3.286	2.000	1.429	1.571	2.714	1.571	1.143	1.571	1.571	1.286	1.429
b_3	3.143	3.571	3.000	0.000	2.000	1.286	1.857	3.143	2.143	1.571	1.714	1.429	1.286	2.429
c_1	2.286	1.857	1.571	1.857	0.000	2.714	2.286	1.571	1.143	1.429	1.286	1.286	1.429	2.571
c_2	1.286	1.857	2.286	2.286	2.857	0.000	2.143	1.857	1.857	1.857	2.143	1.714	2.000	2.000
c_3	3.143	1.286	1.286	2.143	2.714	1.429	0.000	1.571	1.429	2.714	1.286	1.143	1.571	2.714
d_1	2.143	2.857	2.714	3.000	2.143	1.571	1.857	0.000	2.286	1.714	1.857	1.143	1.429	1.714
d_2	1.857	1.286	1.571	1.714	1.857	1.714	2.000	1.571	0.000	2.571	1.714	1.857	2.286	1.714
d_3	2.143	1.143	1.286	1.714	1.571	2.429	3.143	1.286	3.000	0.000	1.143	2.000	2.286	1.714
d_4	1.857	1.429	1.143	1.714	1.286	1.714	1.571	1.571	1.571	1.571	0.000	1.429	1.143	1.429
e_1	1.286	1.143	1.286	1.571	1.571	1.714	1.286	1.286	3.286	2.429	1.286	0.000	3.429	2.286
e_2	1.571	1.286	1.143	1.571	2.000	2.143	1.857	1.429	3.286	3.000	1.000	3.143	0.000	2.000
e_3	2.857	2.143	2.143	3.143	2.857	2.286	2.571	1.571	1.286	1.714	0.857	1.571	1.857	0.000

Table A2
Group consensuses of the eight respondents on the degree of influence among the criteria (unit:%).

Criteria	a_1	b_1	b_2	b_3	c_1	c_2	c_3	d_1	d_2	d_3	d_4	e_1	e_2	e_3
a_1	0.000	2.125	1.875	3.000	3.375	1.250	3.250	2.125	2.250	2.375	2.000	1.375	1.875	2.875
b_1	1.875	0.000	2.625	2.625	1.875	1.375	1.375	2.500	1.375	1.125	1.500	1.375	1.250	2.000
b_2	2.000	2.750	0.000	3.375	1.875	1.375	1.500	2.875	1.500	1.125	1.500	1.500	1.250	1.625
b_3	3.125	3.625	3.125	0.000	1.875	1.375	1.750	3.250	2.000	1.500	1.625	1.375	1.250	2.625
c_1	2.125	1.875	1.625	1.875	0.000	2.750	2.250	1.500	1.125	1.500	1.250	1.250	1.500	2.750
c_2	1.250	1.750	2.125	2.125	2.875	0.000	2.000	1.750	1.750	1.750	2.000	1.750	1.875	2.125
c_3	3.125	1.250	1.250	2.000	2.500	1.375	0.000	1.500	1.375	2.500	1.250	1.250	1.500	2.625
d_1	2.000	3.000	2.750	3.000	2.000	1.625	1.750	0.000	2.125	1.625	1.750	1.125	1.375	1.625
d_2	1.750	1.250	1.500	1.625	1.750	1.625	2.000	1.625	0.000	2.750	1.875	1.750	2.250	1.625
d_3	2.000	1.125	1.250	1.625	1.500	2.250	3.000	1.250	2.875	0.000	1.375	1.875	2.125	1.625
d_4	1.750	1.375	1.125	1.625	1.250	1.625	1.500	1.500	1.625	1.625	0.000	1.375	1.125	1.375
e_1	1.250	1.125	1.375	1.500	1.625	1.625	1.250	1.250	3.125	2.250	1.250	0.000	3.500	2.125
e_2	1.500	1.250	1.125	1.500	2.250	2.375	1.750	1.375	3.125	2.750	1.000	2.875	0.000	1.875
e_3	3.000	2.000	2.000	3.125	3.000	2.500	2.500	1.500	1.375	1.625	0.875	1.500	1.750	0.000

Note: Errors of gap ratio (%) = $\frac{1}{n(n-1)} \sum_{i=1}^n \sum_{j=1}^n \frac{|g_{ij}^{\rho} - g_{ji}^{\rho}|}{g_{ij}^{\rho}} \times 100\% = 4.89\% < 5\%$ (see Eq. (1)), less than 5%, i.e., significant confidence is 95.11%, where $\rho = 8$ denotes the number of experts and t_{ij}^{ρ} is the average influence of criterion i on criterion j , and n denotes number of criteria; here when $n = 14$, $n \times n$ matrix deducts the diagonal elements n ; the number of gap ratio elements is $n(n - 1) = 14 \times 13$.

achieve the aspiration level (zero gaps) in the performance of each e-store. This is an important finding in this study. The proposed model is suitable for dealing with any complex decision-making issues with interdependent criteria. The study has established a causal-effect model of the effect of e-store management and verified the efficiency of the relational structure model using satisfactory statistical techniques.

Previous e-store research has focused on improving context and design, whereas the current study confirms that e-stores are useful and that satisfying customers' needs and giving perfect post-purchase service are very important to e-stores' success. This study also indicates that the performance of the three selected e-stores is rather unsatisfactory in this regard. Their managers must therefore bridge existing gaps in understanding the customers' needs to improve the e-stores' performance.

This idea is a new approach to solving real-world problems (Tzeng's group). First, the traditional model assumes that the criteria are independent from the hierarchical structure, but the relationships between dimensions and criteria are usually interdependent in the real world. Second, the relatively good solution provided by the existing alternatives is replaced by aspiration levels to fit today's competitive markets. Finally, the goal is to focus not only on "influence", "assessment", "ranking" and "selection" but also on "improvement" and "create strategies" to improve e-store performances.

We hope that this article will contribute to enhancing the efficiency of e-stores' marketing strategies. The results of this analysis should help managers to decide how to implement their e-store

business and marketing strategies more effectively. As such, this research provides an in-depth understanding of the management approach for e-store business.

Appendix A

Tables A1 and A2.

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