E-Commerce Websites Promotion of Laptops based on AHP and Fuzzy TOPSIS

Xiaoning Zhu[1], Qun Zhang[1], Jiaqin Yang[2] and Lingping Zhang[1]
[1]School of Economic and Management, University of Science and Technology Beijing
Beijing, China
2Department of Management, Georgia College & State University - Milledgeville
Milledgeville, Georgia
1 zhuxiaoning@ustb.edu.cn, 2 jiaqin.yang@gcsu.edu

Abstract

With the development of electronic commerce, usability on a website is vital to online customers. However, many of these e-commerce applications still do not meet customers' requirements. This paper is an attempt to investigate the current issues and development of e-commerce websites promotion and marketing of the laptop producers, specifically the laptop in a specific market - China. AHP and Fuzzy TOPSIS are employed to evaluate the current e-commerce websites promotion implemented by all major laptop brands in China. The managerial implications and suggestions for future research are also discussed.

Keywords: *E-Commerce Website, Online Promotion, Fuzzy TOPSIS, Empirical Study*

1. Introduction

Nowadays, computer is becoming increasingly important in our daily life, and the laptop is popularized for its convenience. With the development of the internet, an increasing number of customers have used the e-commerce websites to obtain information about products and services, with possible follow-up purchase (Korner and Zimmerman, 2000; Geissler, 2001). E-commerce website quality has become one of the critical factors in attracting e-shoppers to visit a company's online store and learn more about its products and services.

As the most populated nation on the earth, China for the first time has passed the U.S. to become the world's biggest personal-computer market in 2011(Owen, 2011), highlighting the consumer demand for PCs has soared in emerging markets. As discussed earlier, the design and quality of websites of these laptop manufactures are important in terms of market competition. From observations, however, there exist many issues and challenges in the current laptop manufacturers' e-commerce websites regarding the actual performance of those websites in terms of the effectiveness of their promotional effort. In order to provide practical insight and guidelines for improving the promotional effectiveness of the websites of these laptop manufacturers, an investigative empirical study to evaluate these e-commerce websites is needed, which is the primary motivation of this research.

The paper is organized as follows. The next section introduces the related literature about website evaluation. Following is a brief introduction about the fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method used in this research. Section 4 describes an empirical analysis of evaluating the e-commerce websites of the laptop producers in China's laptop market. The primary data for this research are collected through a comprehensive website evaluation. Finally, major issues and challenges for laptop producers in promoting their products through their websites are identified and discussed along with the related managerial implications.

2. Literature Review

E-commerce can be described as “any form of business transaction in which the parties interact electronically rather than by physical exchanges or direct physical contact” (Ecom, 1998). While along with the advancement of information technology, almost all laptop producers have taken the initiative and developed their own e-commerce websites. However, a study by Elliot and Fowell (2000) show that online shoppers have been relatively frustrated with the quality of the websites they visited, particularly such attributes as responsiveness of customer service, ease of site navigation, simplicity of checkout process, and security of transaction and personal information. Swaminathan *et al.*, (1999) argue that consumers evaluate websites when they make purchase decisions and the perception of their shopping experience at the websites plays a major role in creating demand for online purchasing. Investigating online consumers’ website evaluation criteria is important for the companies to develop a website that can attract online shoppers and communicate successfully with their customers, which eventually helps the company to sell its products and satisfy and retain its customers.

Despite evaluating the effectiveness of the e-commerce websites is a well-known topic by many researchers (Thorleuchter and Poel, 2012; Li and Li, 2011; Salim and Abdelmajid, 2010; Nielsen, 1999; Nielsen and Tahir, 2001), Goi (2012) observes that, as far as website design and development is concerned, few sets of criteria are available on the Web and from the researchers' web site evaluation criteria. In the mean time, most of the research in the area of website evaluation indicates that it is a complicated and difficult task (Jones and Hughes, 2001; Serafeimidis and Smithson, 2000).

Moon (2004) reports that Internet users’ satisfaction with websites was determined by information quantity, website design, transmission speed, user-friendliness of the structure and update pace. Kim and Stoel (2004) study the relationship between online consumers’ perceived apparel website quality and their satisfaction with the website. A study by Davidavičienė and Tolvaišas (2012) identifies the quality factors of an e-commerce website and services based on the survey of Lithuanian online store visitors. Sohrabi *et al.*, (2012) propose a framework and an appropriate structure to make the websites more flexible and highly functional using a hybrid genetic algorithm and neural network system. An empirical study by Jowkar and Didegah (2010) evaluates 24 Iranian newspapers' web sites. The study of Sun *et al.*, (2012) report an empirical research on the service quality of the websites of small businesses in Hong Kong, The research is based on a questionnaire survey of 124 netizens (net citizen) and a review of 30 websites in terms of 60 features related to website content. Albadvi and Saddad (2012) evaluate the web site of Iranian tourism and hospitality organizations. Sigman and Boston (2013) develop an e-commerce web site evaluation tool - digital discernment which can provide a listing of criteria to assess e-commerce sites.

The TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method selected for the data analysis purposes in this research was first proposed in 1981 (Hwang and Yoon, 1981). Many proposed numerical examples have shown that this new method can avoid some weaknesses of the existing multi-attribute methods (Byun and Lee, 2005; Deng, 2006; Ecer, 2007). Fuzzy TOPSIS is employed to solve the multi-criteria evaluation problems (Muralidhar et al., 2013; Ataei, *et al.*, 2008; Gulcin and Gizem, 2011; Zeki and Rifat, 2012).

In summary, the evaluation of websites both in theory and in practice has proven to be very important and quite complex, and there have been limited researches in the current literature focusing on the e-commerce website evaluation of the laptop producers in China - the largest laptop market in the world.

3. First-order Headings

3.1. Fuzzy AHP Model

First, it is necessary to review the related Fuzzy Theory:

Definition 1: A Fuzzy set $\tilde{a}$ in a universe of discourse X is characterized by a membership function $\mu_{\tilde{a}}(x)$ which associates with each element x in X , a real number in the interval [0, 1]. The function of $\mu_{\tilde{a}}(x)$ is termed the grade of membership of x in $\tilde{a}$ (Zadeh, 1965). The present study uses triangular Fuzzy numbers. $\tilde{a}$ can be defined by a triplet (a_1, a_2, a_3). Its conceptual schema and mathematical form are shown as below:

$$\mu_{\tilde{a}}(x)\begin{cases} 0 & x \le a \\ \dfrac{x-a_1}{a_2-a_1} & a_1 \prec x \le a_2 \\ \dfrac{a_3-x}{a_3\text{-}a_2} & a_2 \prec x \le a_3 \\ 1 & x \succ a_3 \end{cases}$$

Definition 2: Let $\tilde{a} = (a_1, a_2, a_3)$ and $\tilde{b} = (b_1, b_2, b_3)$ be two triangular fuzzy numbers. According to Wang (2009), a distance measure function ($\tilde{a}$, $\tilde{b}$) can be defined as below:

$$d(\tilde{a},\tilde{b}) = \sqrt{\frac{1}{3}[(a_1-b_1)^2+(a_2-b_2)^2+(a_3-b_3)^2]}$$

Definition 3: Let a triangular Fuzzy number $\tilde{a}$, then α -cut defined as below:

$$\tilde{a}_\alpha = [(a_2-a_1)\alpha + a_1, a_3-(a_3-a_2)\alpha]$$

Definition 4: Let $\tilde{a} = (a_1, a_2, a_3)$, $\tilde{b} = (b_1, b_2, b_3)$ be two triangular Fuzzy number and $\tilde{a}_\alpha$, $\tilde{b}_\alpha$ be α -cut, $\tilde{a}$ and $\tilde{b}$, then the method is defined to calculate the divided between $\tilde{a}$ and $\tilde{b}$ as follows (Kwang, 2005):

$$\frac{\tilde{a}_\alpha}{\tilde{b}_\alpha} = [\frac{(a_2-a_1)\alpha+a_1}{-(b_3-b_2)\alpha+b_3}, \frac{-(a_3-a_2)\alpha+a_3}{(b_2-b_1)\alpha+b_1}]$$

When $\alpha = 0$,

$$\frac{\tilde{a}_0}{\tilde{b}_0} = [\frac{a_1}{b_3}, \frac{a_3}{b_1}]$$

When $\alpha = 1$

$$\frac{\tilde{a}_1}{\tilde{b}_1}=[\frac{(a_2-a_1)+a_1}{-(b_3-b_2)+b_3},\frac{-(a_3-a_2)+a_3}{(b_2-b_1)+b_1}]$$

$$\frac{\tilde{a}_1}{\tilde{b}_1}=[\frac{a_2}{b_2},\frac{a_2}{b_2}]$$

So the approximated value of $\tilde{a}/\tilde{b}$ will be

$$\frac{\tilde{a}}{\tilde{b}}=[\frac{a_1}{b_3},\frac{a_2}{b_2},\frac{a_3}{b_1}]$$

Definition 5: Assuming that both $\tilde{a}=(a_1,a_2,a_3)$ and $\tilde{b}=(b_1,b_2,b_3)$ are real numbers, the distance measurement $d(\tilde{a},\tilde{b})$ is identical to the Euclidean distance (Chen, 2000).

The basic operations on Fuzzy triangular numbers are as follows (Yang and Hung, 2007):

For approximation of multiplication: $\tilde{a}\times\tilde{b}=(a_1\times b_1, a_2\times b_2, a_3\times b_3)$

For addition： $\tilde{a}+\tilde{b}=(a_1+b_1, a_2+b_2, a_3+b_3)$

Given the above-mentioned Fuzzy theory, the proposed Fuzzy AHP procedure can be defined as follows (Isiklar and Buyukozkan, 2006):

Step1: AHP uses several small sub-problems to present the decision problem, and the problem is decomposed into a hierarchy with a goal at the top, criteria and sub-criteria at levels and sub-levels and decision alternatives at the bottom of the hierarchy.

Step2: The comparison matrix involves the comparison in pairs of the elements of constructed hierarchy. The aim is to set their relative priorities with respect to each of the elements at the next higher level.

$$D=\begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \\ \vdots \\ C_n \end{array}\begin{array}{c} \begin{array}{ccccc} C_1 & C_2 & C_3 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & x_{13} & \cdots & x_{1n} \\ x_{21} & x_{22} & x_{23} & \cdots & x_{2n} \\ x_{31} & x_{32} & x_{33} & \cdots & x_{3n} \\ \vdots & & & & \\ x_{n1} & x_{n1} & x_{n1} & \cdots & x_{n1} \end{bmatrix} \end{array}$$

Where x_{ij} is the degree preference of i^{th} criterion over j^{th} criterion. Before the calculation of vector of priorities, the comparison matrix has to be normalized into the range of [0, 1] by the equation below:

$$r_{ij}=\frac{x_{ij}}{\sum_{i=1}^{n}x_{ij}}$$

Step 3: The consistency ratio need to be identified to reflect the consistency of the decision maker's judgments during the evaluation phase.

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

Where CI is the consistency ratio, λ_{max} is the principal eigenvalue of the judgement matrix and N is the order of the judgement matrix. The consistency ratio should be lower than 0.10 to accept the AHP results as consistent.

Step 4: In the next step, transform r_{ij} into the fuzzy numbers.

Step 5：Calculate the average of the elements of each rows from matrix obtained from step 4, by Definition 4.

3.2. Fuzzy Membership Function

In the evaluating process, the weights expressed with the linguistic terms, represent the important degrees of criteria from experts via surveys on subjective assessments. These linguistic terms are categorized into very low (VL), low (L), medium (M), high (H) and very high (VH). Assume that all linguistic terms can be transferred into triangular fuzzy numbers, and these fuzzy numbers are limited in [0, 1]. As a rule of thumb, each rank is assigned an evenly spread membership function that has an interval of 0.30 or 0.25(Wang, 2009).

Based on assumptions above, a transformation table can be found as shown in Table 1. Figure 1 illustrates the Fuzzy membership function (Yang and Hung, 2007).

Table 1. Transformation for Fuzzy Membership Functions

Rank	Sub-criteria grade	Membership function
Very Low (VL)	1	(0.00,0.10,0.25)
Low (L)	2	(0.15,0.30,0.45)
Medium (M)	3	(0.35,0.50,0.65)
High (H)	4	(0.55,0.70,0.85)
Very High (VH)	5	(0.75,0.90,1.00)

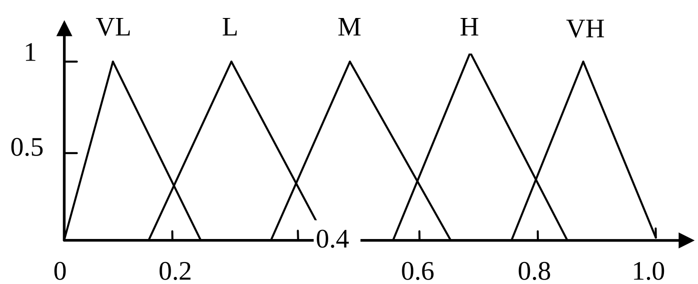


Figure 1. Fuzzy Triangular Membership Functions

3.3. Fuzzy TOPSIS Model

To describe the evaluation method clearly, the procedure of fuzzy TOPSIS is presented as below. It is formulated that a Fuzzy Multiple Criteria Decision Making (FMCDM) problem about the comparative evaluation of the websites of those laptop manufacturers. The FMCDM problem can be concisely expressed in matrix format as follows:

$$\begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ \vdots \\ A_n \end{array} \begin{array}{c} \begin{array}{ccccc} C_1 & C_2 & C_3 & \cdots & C_n \end{array} \\ \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \tilde{x}_{13} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \tilde{x}_{23} & \cdots & \tilde{x}_{2n} \\ \tilde{x}_{31} & \tilde{x}_{32} & \tilde{x}_{33} & \cdots & \tilde{x}_{3n} \\ \vdots & & & & \\ \tilde{x}_{n1} & \tilde{x}_{n1} & \tilde{x}_{n1} & \cdots & \tilde{x}_{n1} \end{bmatrix} \end{array}$$

$$\tilde{W} = [\tilde{w}_1, \tilde{w}_2, \cdots \tilde{w}_n]$$

Where $x_{ij}, i = 1, 2, \cdots, m; j = 1, 2, \cdots, n$ and $\tilde{w}_j, j = 1, 2, \cdots, n$ are linguistic triangular Fuzzy numbers, $\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$ and $\tilde{w}_j = (a_{j1}, b_{j2}, c_{j3})$. The normalized Fuzzy decision matrix is denoted by $\tilde{R} = [\tilde{r}_{ij}]_{m \times n}$.

The weighted Fuzzy normalized decision matrix is shown as follows:

$$V = \begin{bmatrix} \tilde{v}_{11} & \tilde{v}_{12} & \tilde{v}_{13} & \cdots & \tilde{v}_{1n} \\ \tilde{v}_{21} & \tilde{v}_{22} & \tilde{v}_{23} & \cdots & \tilde{v}_{2n} \\ \tilde{v}_{31} & \tilde{v}_{32} & \tilde{v}_{33} & \cdots & \tilde{v}_{3n} \\ \vdots & & & & \\ \tilde{v}_{n1} & \tilde{v}_{n1} & \tilde{v}_{n1} & \cdots & \tilde{v}_{n1} \end{bmatrix} = \begin{bmatrix} \tilde{w}_1\tilde{r}_{11} & \tilde{w}_2\tilde{r}_{12} & \tilde{w}_3\tilde{r}_{13} & \cdots & \tilde{w}_n\tilde{r}_{1n} \\ \tilde{w}_1\tilde{r}_{21} & \tilde{w}_2\tilde{r}_{22} & \tilde{w}_3\tilde{r}_{23} & \cdots & \tilde{w}_n\tilde{r}_{2n} \\ \tilde{w}_1\tilde{r}_{31} & \tilde{w}_2\tilde{r}_{32} & \tilde{w}_3\tilde{r}_{33} & \cdots & \tilde{w}_n\tilde{r}_{3n} \\ \vdots & & & & \\ \tilde{w}_1\tilde{r}_{m1} & \tilde{w}_2\tilde{r}_{m2} & \tilde{w}_3\tilde{r}_{m3} & \cdots & \tilde{w}_n\tilde{r}_{mn} \end{bmatrix}$$

Given the above Fuzzy theory, the proposed Fuzzy TOPSIS procedure is then defined as follows:

Step 1: choose the $x_{ij}, i = 1, 2, \cdots, m; j = 1, 2, \cdots, n$ for alternatives with respect to criteria and $\tilde{w}_j, j = 1, 2, \cdots, n$ for the weight of the criteria.

Step 2: Construct the weighted normalized Fuzzy decision matrix V.

Step 3: Identify positive ideal (A^+) and negative ideal (A^-) solutions:

$$A^+ = \left\{ \tilde{v}_1^+, \tilde{v}_2^+, \cdots \tilde{v}_n^+ \right\}$$
$$= \left\{ (\max_i \tilde{v}_{ij} \middle| i = 1, 2, \cdots, m), j = 1, 2, \cdots, n \right\}.$$
$$A^- = \left\{ \tilde{v}_1^-, \tilde{v}_2^-, \cdots \tilde{v}_n^- \right\}$$
$$= \left\{ (\min_i \tilde{v}_{ij} \middle| i = 1, 2, \cdots, m), j = 1, 2, \cdots, n \right\}.$$

Considering that the elements $\tilde{v}_{ij}$ are normalized positive triangular fuzzy numbers and their ranges belong to the closed interval [0, 1], the positive ideal and negative ideal solutions can be defined as $\tilde{v}_j^+ = (1,1,1)$ and $\tilde{v}_j^- = (0,0,0), j = 1, 2, \cdots, n$ (Isiklar and Buyukozkan, 2006).

Step 4: Calculate separation measures. The distance of each alternative from A^+ and A^- can be identified as follows:

$$d_i^+ = \frac{1}{n}\sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^+), i = 1, 2, \cdots, m$$

$$d_i^- = \frac{1}{n}\sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^-), i = 1, 2, \cdots, m$$

Step 5: Calculate the similarities to ideal solution:

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-}$$

Step 6: Rank preference order. Rank alternatives according to CC_i in descending order (Yang and Hung, 2007).

4. Data Collection and Results Analysis

There are over twenty brands in China's current laptop market. In this study, considering the gaps between the famous laptop companies and those relatively not so famous laptop companies in terms of their financial resources and consequently their websites stages, 17 laptop brands shown in table 2 are selected based on their popularity.

Table 2. Transformation for Fuzzy Membership Functions

No.	Brand	Regtime	Country
1	Lenovo	1984	Chinese Mainland
2	Acer	1976	Taiwan
3	Dell	1984	USA
4	Asus	1989	Taiwan
5	Samsung	1938	Korea
6	Hedy	1997	Chinese Mainland
7	Sony	1946	Japan
8	HP	1939	USA
9	Apple	1976	USA
10	Toshiba	1875	Japan
11	Fujitsu	1935	Japan
12	Shenzhou	2001	Chinese Mainland
13	Haier	1984	Chinese Mainland
14	Msi	1986	Taiwan
15	Gateway	1985	USA
16	Tshighua tongfang	1997	Chinese Mainland
17	Gigabyte	1986	Taiwan

A pre-designed observation sheet including five sections (visual effect of the website; technology features; popularity of the website; the available information of the website before sale; the available information of the website after sale) is used to collect all necessary data from the proposed 17 e-commerce websites. Three raters participated to make an appropriate rating, and the selected items from all websites are rated with the widely used Little Scale, *i.e.*, from a scale of 1 (being the worst) to 5 (meaning excellent) accordingly.

The collected data in terms of websites' visual effect, technology features, popularity, and available online laptop information are summarized in Table 3 to Table 7 below. A large proportion（47%) of observed websites have problems in color assortment as shown in Table 3. About 29% don't have video clips, which is clearly more attractive and persuasive to potential customers. As shown in Table 4, the average leadtime of opening a selected laptop company's e-commerce webpage is relatively slow.

Table 3. Summary of the Visual Effect of the Website

Category	Ranking	Number	%
Color assortment	Need improvement (＜2.67)	8	47
	Satisfied (≥2.67)	9	53
Total		17	100
Website structures	Need improvement (＜2.67)	4	24
	Satisfied (≥2.67)	13	76
Total		17	100
Visual attraction	Need improvement (＜2.67)	5	29
	Satisfied (≥2.67)	12	71
Total		17	100
Multimedia	Need improvement (＜2.67)	2	12
	Satisfied (≥2.67)	15	88
Total		17	100
Video	Exist in website (1)	12	71
	No Exist in website (0)	5	29
Photo	Exist in website (1)	17	100
	No Exist in website (0)	0	0

Table 4.Summary of the Technology of the Website

Category	Ranking	Number	%
Average leadtime of main page	Time-consuming (＜4s)	15	88
	Time-consuming (≥4s)	2	12
Total		17	100
Average leadtime of main tab on the main page	Time-consuming (＜4s)	5	29
	Time-consuming (≥4s)	12	71
Total		17	100
Problems with opening the main page	No Broken Links (1)	17	100
	Exist Broken Links (0)	0	0
Total		17	100

The popularity among online shoppers is obviously a very important measure for the effectiveness of a laptop manufacturer's e-commerce website. In this research, four measures are employed to assess the popularity of the selected websites based on the related literature: (a) online traffic rank, (b) Daily page-views per user for this website (c) average visit time, and most importantly, (d) Web Impact Factor (WIF) (Thelwall, 2002). In the related current research, the rank of a website traffic flow is measured and obtained from alexa.com Search, *i.e.*, Google is ranked as No. 1 since it has the most visitors total by its count. The good news is, as shown in Table 5, most observed websites have scored relatively high in terms of popularity. However, for 82% of observed websites (14 out of 17) selected for which daily page-viewing per user is lower than 4 pages, which at least implying that the users of the websites don't use them to search for the desired laptop products. Currently, WIF (Web Impact Factor) has been used as a quantitative tool for ranking, evaluating, categorizing, and comparing web sites. In this paper, the overall WIF is used to measure the popularity of a websites. A clear indication here is that a large majority of observed websites (46%) have a WIF less than 10%, implying that there are very limited websites outside have a link to those laptop e-commerce websites, in another word, the popularity of those websites is relatively very low.

Table 5. Summary of the Popularity of the Websites

Category	Ranking	Number	%
Traffic rank	(0,20000]	12	70
	(20000, 50000]	3	18
	(50000, 100000]	1	6
	(100000, +∞)	1	6
Total		17	100
Daily pageviews per user for this website	(0, 2]	3	18
	(2, 4]	11	64
	(4, +∞)	3	18
Total		17	100
Average visit time of each webpage (s)	(0, 2]	8	47
	(2, 4]	7	41
	(4, +∞)	2	12
Total		17	100
WIF (web impact factors) (%)	(0, 10]	16	46
	(10, 20]	10	28
	(20, 50]	8	23
	(50, 100]	1	3
Total		35	100

The most important and related data collected in this research, perhaps, is the current available laptop information on the websites, which are summarized in Table 6 and Table 7. It can be seen again that in this regard, there are many issues and challenges in the current laptop manufacturers' websites in terms of its quality and design for the intended promotional efforts. For example, as shown in Table 6, 46% of observed websites place their company introductions on their homepage. However, since most of the visitors of the websites want to search for some information of laptops rather than the company introduction, it is strongly recommended that all the laptop manufacturers' websites should place the information related to their products on their homepages. Surprisingly, half of the selected websites don't update their websites very frequently. Multi-criteria search capacity is also very important such a helpful feature for the websites of those laptop producers, as it can help the potential customers find their desired laptop products more easily. However, from the data collected in this research, 59% of the observed websites don't have such functions at all.

Table 6. Summary of the Available Mobile Information of the Website before Sale

Category	Ranking	Number	%
Contents on the homepage	Mobile phone related (1)	8	47
	Company introduction (0)	9	53
Total		17	100
Multi-languages	Exist (1)	17	100
	Non exist (0)	0	0
Total		17	100
Website update	In a month	5	29
	One-two months	4	24
	Two-three months	3	18
	Three-four months	3	18
	More than four months	2	11
Total		17	100
Multi-restriction search	Exist (1)	7	41
	Non exist (0)	10	59
Total		17	100
Product features	Exist (1)	17	100
	Non exist (0)	0	0

Total		17	100
Product specification	Exist (1)	14	82
	Non exist (0)	3	18
Total		17	100
Product video	Exist (1)	5	29
	Non exist (0)	12	71
Total		17	100
Product accessories	Exist (1)	14	82
	Non exist (0)	3	18
Total		17	100
Overall rating of products	Need improvement (< 2.67)	3	18
	Satisfied (≥2.67)	14	82
Total		17	100
Message board or forums	Exist (1)	15	88
	Non exist (0)	2	12
Total		17	100
Promptly reply in forums or message board	In a month	15	100
	More than one month	0	0
Total		15	100

Table 7. Summary of the Available Mobile Information of the Website after Sale

Category	Ranking	Number	%
Basic troubleshooting of mobile phone	Exist (1)	15	88
	Non exist (0)	2	12
Total		17	100
Detailed warranty	Exist (1)	11	65
	Non exist (0)	6	35
Total		17	100
Email contact for customers	Exist (1)	9	53
	Non exist (0)	8	47
Total		17	100
Online customer services	Exist (1)	10	59
	Non exist (0)	7	41
Total		17	100
Detailed information of servicing locations	Exist (1)	14	82
	Non exist (0)	3	18
Total		17	100
Customers complaining box	Exist (1)	7	41
	Non exist (0)	10	59
Total		17	100

5. Solutions from Fuzzy AHP and TOPSIS Analysis

To further identify the relative importance of the major measures for evaluating laptop website effectiveness in terms of promotional and marketing power discussed in the earlier section, the TOPSIS, as a quantitative tool, is employed in this research. These specific measures are listed and named in Table 8. The decision problem consists of three levels: at the highest level, the objective of the problem is situated while in the second level, the criteria are listed, and in the third level, the sub-criteria are listed.

Table 8. The Measures of the Qualities of the Websites of Laptop Producers

Goal	Aspects	Criteria
The qualities of the websites of laptop producers	C_1Visual effect of the website	SC_1 Color assortment SC_2 Website structures SC_3 Visual attraction SC_4 Multi-media
	C_2Technology performance of the website	SC_5 Average leadtime of main page SC_6 Average leadtime of main tab on the main page
	C_3Popularity of the website	SC_7 Traffic ranking SC_8 Daily pageviews per user for this website SC_9 Daily time on site SC_{10} WIF
	C_4Laptop information of the website before sale	SC_{11} Contents on the homepage SC_{12} Multi-languages SC_{13} Website update SC_{14} Multi-restriction search SC_{15} Products introduction SC_{16} Message board or forums SC_{17} Timely reply in forums or message board
	C_5Laptop information of the website after sale	SC_{18} Basic troubleshooting of laptop SC_{19} Detailed warranty SC_{20} Email contact for customers SC_{21} Online customer services SC_{22} Detailed information of servicing locations

As mentioned, the AHP methodology first necessitates the pairwise comparisons of the criteria and sub-criteria in order to identify the weights. Considering the limited of the pages, part of these consistent comparison matrices is shown in Table 9. The normalized priority weights of the criteria and sub-criteria in Table 9 are shown in Table 10. The comparison matrices are consistent ($CI < 0.1$) according to Isiklar and Buyukozkan (2006). In the next step, the Fuzzy membership function discussed in Section 3.2 is applied to transform Table 10 into Table 11 as explained by the following example. If the numeric rating is 0.45, then its Fuzzy linguistic variable is "M". Therefore, the new pairwise comparison matrix is shown in Table 11:

Table 9. Part of the Pairwise Comparison Matrix of the Criteria and Sub-criteria

No.	C_1	C_2	C_3	C_4	C_5	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6
C_1	1	1	0.33	0.2	1	-	-	-	-		
C_2	1	1	0.33	0.2	1	-	-	-	-		
C_3	3	3	1	0.6	3	-	-	-	-		
C_4	5	5	1.67	1	5	-	-	-	-		
C_5	1	1	0.33	0.2	1	-	-	-	-		
SC_1	-	-	-	-	-	1	0.33	1	1	3	3
SC_2	-	-	-	-	-	3	1	3	3	7	3
SC_3	-	-	-	-	-	1	0.33	1	1	3	3
SC_4	-	-	-	-	-	1	0.33	1	1	3	3
SC_5						0.33	0.14	0.33	0.33	1	0.33
SC_6						0.33	0.33	0.33	0.33	3	1

Table 10. Part of the Normalized Pairwise Comparison Matrix of the Criteria and Sub-criteria

No.	C_1	C_2	C_3	C_4	C_5	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6
C_1	0.09	0.09	0.09	0.09	0.09	-	-	-	-		
C_2	0.09	0.09	0.09	0.09	0.09	-	-	-	-		
C_3	0.27	0.27	0.27	0.27	0.27	-	-	-	-		
C_4	0.45	0.45	0.45	0.45	0.45	-	-	-	-		
C_5	0.09	0.09	0.09	0.09	0.09	-	-	-	-		
SC_1	-	-	-	-	-	0.167	0.167	0.167	0.167	0.19	0.25
SC_2	-	-	-	-	-	0.5	0.5	0.5	0.5	0.44	0.25
SC_3	-	-	-	-	-	0.167	0.167	0.167	0.167	0.19	0.25
SC_4	-	-	-	-	-	0.167	0.167	0.167	0.167	0.19	0.25
SC_5						0.5	0.3	0.5	0.5	0.25	0.25
SC_6						0.5	0.7	0.5	0.5	0.75	0.75

Table 11. Part of the Pairwise Comparison Matrix of the Criteria and Sub-criteria using Fuzzy Linguistic Variables

No.	C_1	C_2	C_3	C_4	C_5	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6
C_1	VL	VL	VL	VL	VL	-	-	-	-		
C_2	VL	VL	VL	VL	VL	-	-	-	-		
C_3	L	L	L	L	L	-	-	-	-		
C_4	M	M	M	M	M	-	-	-	-		
C_5	VL	VL	VL	VL	VL	-	-	-	-		
SC_1	-	-	-	-	-	L	L	L	L	L	L
SC_2	-	-	-	-	-	M	M	M	M	M	L
SC_3	-	-	-	-	-	L	L	L	L	L	L
SC_4	-	-	-	-	-	L	L	L	L	L	L
SC_5						M	L	M	M	L	L
SC_6						M	H	M	M	VH	VH

The fuzzy linguist variables of the above matrix are then transformed into a Fuzzy triangular membership function. In the next step, we calculate the average of the elements of each row, then the average criteria weights are derived: $W_1=(0.11,0.25,0.41)$, $W_2=(0.41,0.64,0.81)$, $W_3=(0.18,0.35,0.52)$, $W_4=(0.18,0.35,0.52)$, $W_5=(0.46,0.66,0.94)$, $W_6=(0.46,0.66,0.94)$, $W_7=(0.32,0.54,0.78)$, $W_8=(0.46,0.68,0.88)$, $W_9=(0.46,0.68,0.88)$, $W10=(0.58,0.82,1)$, $W_{11}=(0.5,0.72,0.94)$, $W_{12}=(0.46,0.66,0.94)$, $W_{13}=(0.62,0.88,1)$, $W_{14}=(0.06,0.28,0.5)$, $W_{15}=(0.54,0.78,0.94)$, $W_{16}=(0.46,0.66,0.94)$, $W_{17}=(0.46,0.66,0.94)$, $W_{18}=(0.32,0.54,0.78)$, $W_{19}=(0.22,0.4,0.64)$, $W_{20}=(0.42,0.62,0.88)$, $W_{21}=(0.12,0.32,0.54)$, $W_{22}=(0.2,0.48,0.64)$.

The original decision matrix is identified by the raters by observing the websites of the 17 laptop brands, and the normalized decision matrix is then derived from the original data as shown in Table 12.

The larger, the better type (Yang and Hung, 2007):

$$r_{ij} = \frac{\left[x_{ij} - \min\left\{x_{ij}\right\}\right]}{\left[\max\left\{x_{ij}\right\} - \min\left\{x_{ij}\right\}\right]}$$

The smaller, the better type:

$$r_{ij} = \frac{\left[\max\left\{x_{ij}\right\} - x_{ij}\right]}{\left[\max\left\{x_{ij}\right\} - \min\left\{x_{ij}\right\}\right]}$$

For the present study, SC_5, SC_6 and SC_7 belong to the smaller-the-better type, and the others belong to the larger-the-better type. Then the normalized decision matrix using Fuzzy linguistic variables shown in Table 13 can be identified by the Fuzzy membership function discussed in Section 3.2.

Table 12. Part of the Normalized Decision Matrix for TOPSIS Analysis

No.	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6
A_1	0.5	1	1	0.5	1.00	0.5
A_2	0	0	0	0	1.00	0.5
A_3	0.5	0.5	0.33	0.5	0.67	0.25
A_4	0.5	0.5	0.33	1	0.33	0.75
A_5	1	0.5	0.67	1	0.33	0.25
A_6	1	1	0.67	0	0.33	1
A_7	1	1	0. 67	1	0.67	0.5
A_8	0	0	0	1	0.33	0.5
A_9	1	0.5	1	1	0.67	0.5
A_{10}	1	0.5	0.33	1	0.33	0.5
A_{11}	0.5	0.5	0.67	1	0.67	0.5
A_{12}	0.5	0	0.33	0.5	0.67	0.25
A_{13}	0.5	0.5	0.33	0.5	0.33	0.5
A_{14}	1	0.5	0.67	1	0.67	0
A_{15}	0.5	0	0.33	0.5	0.67	0.5
A_{16}	0.5	0	0	1	0.33	0.5
A_{17}	0.5	0	0. 33	1	0.00	0

Table 13. Part of the Normalized Decision Matrix using Fuzzy Linguistic Variables

No.	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6
A_1	M	VH	VH	M	VH	M
A_2	VL	VL	VL	VL	VH	M
A_3	M	M	L	M	H	L
A_4	M	M	L	VH	L	H
A_5	VH	M	H	VH	L	L
A_6	VH	VH	H	VL	L	VH
A_7	VH	VH	H	VH	H	M
A_8	VL	VL	VL	VH	L	M
A_9	VH	M	VH	VH	H	M
A_{10}	VH	M	L	VH	L	M
A_{11}	M	M	H	VH	H	M
A_{12}	M	VL	L	M	H	L
A_{13}	M	M	L	M	L	M
A_{14}	VH	M	H	VH	H	VL
A_{15}	M	VL	L	M	H	M
A_{16}	M	VL	VL	VH	L	M
A_{17}	M	VL	L	VH	VL	VL

The Fuzzy linguistic variable is then transformed into a Fuzzy triangular membership function as shown in Table 14, and then the resulting Fuzzy weighted decision matrix can be derived based on Table 14 and the weights identified before. As discussed in 3.3, the positive ideal and negative ideal solutions can be defined as $\tilde{v}_j^+ = (1,1,1)$ and $\tilde{v}_j^- = (0,0,0),\ j = 1,2,\cdots,n$. The distance of each alternative from A^+ and A^-, as well as the similarities to an ideal solution, is obtained in Table 15.

Table 14. Part of the Fuzzy Decision Matrix

No.	SC_1	SC_2	SC_3	SC_4	SC_5	SC_6
A_1	(0.35,0.50,0.65)	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.35,0.50,0.65)	(0.75,0.90,1.00)	(0.35,0.50,0.65)
A_2	(0.00,0.10,0.25)	(0.00,0.10,0.25)	(0.00,0.10,0.25)	(0.00,0.10,0.25)	(0.75,0.90,1.00)	(0.35,0.50,0.65)
A_3	(0.35,0.50,0.65)	(0.35,0.50,0.65)	(0.15,0.30,0.45)	(0.35,0.50,0.65)	(0.55,0.70,0.85)	(0.15,0.30,0.45)
A_4	(0.35,0.50,0.65)	(0.35,0.50,0.65)	(0.15,0.30,0.45)	(0.75,0.90,1.00)	(0.15,0.30,0.45)	(0.55,0.70,0.85)
A_5	(0.75,0.90,1.00)	(0.35,0.50,0.65)	(0.55,0.70,0.85)	(0.75,0.90,1.00)	(0.15,0.30,0.45)	(0.15,0.30,0.45)
A_6	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.55,0.70,0.85)	(0.00,0.10,0.25)	(0.15,0.30,0.45)	(0.75,0.90,1.00)
A_7	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.55,0.70,0.85)	(0.75,0.90,1.00)	(0.55,0.70,0.85)	(0.35,0.50,0.65)
A_8	(0.00,0.10,0.25)	(0.00,0.10,0.25)	(0.00,0.10,0.25)	(0.75,0.90,1.00)	(0.15,0.30,0.45)	(0.35,0.50,0.65)
A_9	(0.75,0.90,1.00)	(0.35,0.50,0.65)	(0.75,0.90,1.00)	(0.75,0.90,1.00)	(0.55,0.70,0.85)	(0.35,0.50,0.65)
A_{10}	(0.75,0.90,1.00)	(0.35,0.50,0.65)	(0.55,0.70,0.85)	(0.75,0.90,1.00)	(0.15,0.30,0.45)	(0.35,0.50,0.65)
A_{11}	(0.35,0.50,0.65)	(0.35,0.50,0.65)	(0.55,0.70,0.85)	(0.75,0.90,1.00)	(0.55,0.70,0.85)	(0.35,0.50,0.65)
A_{12}	(0.35,0.50,0.65)	(0.00,0.10,0.25)	(0.15,0.30,0.45)	(0.35,0.50,0.65)	(0.55,0.70,0.85)	(0.15,0.30,0.45)
A_{13}	(0.35,0.50,0.65)	(0.35,0.50,0.65)	(0.15,0.30,0.45)	(0.35,0.50,0.65)	(0.15,0.30,0.45)	(0.35,0.50,0.65)
A_{14}	(0.75,0.90,1.00)	(0.35,0.50,0.65)	(0.55,0.70,0.85)	(0.75,0.90,1.00)	(0.55,0.70,0.85)	(0.00,0.10,0.25)
A_{15}	(0.35,0.50,0.65)	(0.00,0.10,0.25)	(0.15,0.30,0.45)	(0.35,0.50,0.65)	(0.55,0.70,0.85)	(0.35,0.50,0.65)
A_{16}	(0.35,0.50,0.65)	(0.00,0.10,0.25)	(0.00,0.10,0.25)	(0.75,0.90,1.00)	(0.15,0.30,0.45)	(0.35,0.50,0.65)
A_{17}	(0.35,0.50,0.65)	(0.00,0.10,0.25)	(0.15,0.30,0.45)	(0.00,0.10,0.25)	(0.75,0.90,1.00)	(0.00,0.10,0.25)
W	(0.11,0.25,0.41)	(0.41,0.64,0.81)	(0.18,0.35,0.52)	(0.18,0.35,0.52)	(0.46,0.66,0.94)	(0.46,0.66,0.94)

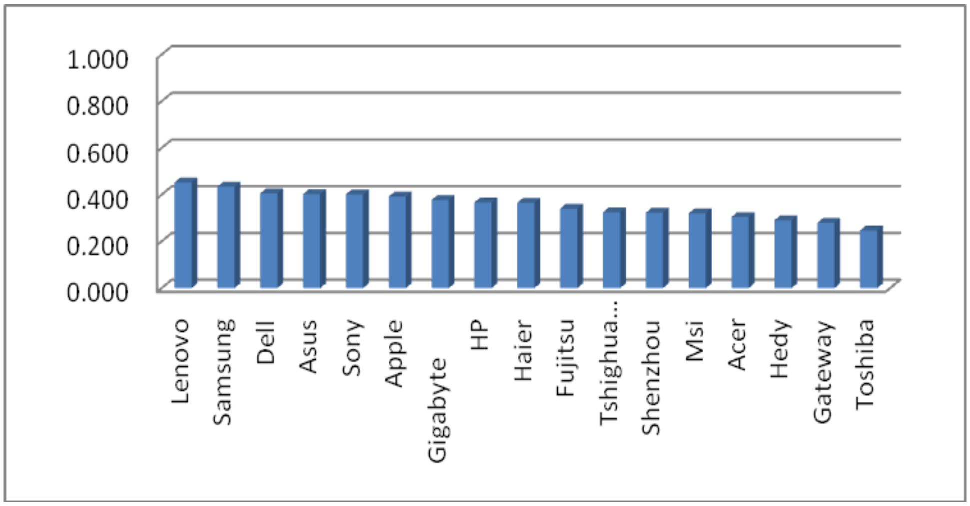
Table 15. The Distance of each Alternative from A^+ and A^-

No.	d_i^+	d_i^-	CC_i
A_1	0.593	0.490	0.452
A_2	0.739	0.324	0.305
A_3	0.641	0.437	0.406
A_4	0.642	0.433	0.403
A_5	0.611	0.469	0.434
A_6	0.752	0.308	0.290
A_7	0.644	0.432	0.401
A_8	0.678	0.394	0.367
A_9	0.652	0.421	0.392
A_{10}	0.792	0.260	0.247
A_{11}	0.702	0.362	0.340
A_{12}	0.720	0.343	0.323
A_{13}	0.677	0.391	0.366
A_{14}	0.723	0.340	0.320
A_{15}	0.763	0.295	0.279
A_{16}	0.719	0.346	0.325
A_{17}	0.668	0.405	0.377

In order to see the result more clearly, the resulting Fuzzy TOPSIS analysis is shown in Figure 2.

The result of observed websites shows that all the value of the similarities to an ideal solution of 17 laptop brands (about 60% of the websites selected) is lower than 0.50. Put it into words, that is, most observed laptop manufacturers' websites have a room for a significant improvement in terms of promoting their laptop products and services through better and improved website design and updates.

Figure 2. Summary of the Evaluation of the Websites of the 17 Laptop Brands



6. Conclusions and Suggestions for Future Research

This study is focused on comparing and evaluating the e-commerce websites of the laptop producers, including both domestic and international laptop producers competing with a variety of different marketing strategies and competitive advantages in China's laptop market. The objectives for this research are threefold: (1) to examine and evaluate the effectiveness of 17 popular laptop manufacturers' e-commerce websites in China; (2) to identify major issues and challenges for those laptop producers in utilizing their e-commerce websites in promoting and marketing their laptop products and services; and (3) to discuss and explore the potential managerial implications for future research.

The primary data for this research are collected through a comprehensive website evaluation. Fuzzy TOPSIS is employed to evaluate the current status and effectiveness of 17 selected popular laptop manufacturers' e-commerce websites. According to the criteria weights derived from this section earlier, the relative top three important measures to evaluate a laptop manufacturer's websites are (1) Website update, and its weight = (0.62, 0.88, 1); (2) WIF, and its weight = (0.58, 0.82, 1); and (3) Product introduction, and its weight = (0.54,0.78,0.94). As such, several important managerial implications are: (a) place attractive laptop product and service content information on the homepage of its website timely; (b) apply the detailed laptop introduction to the customers to make sure that they can find the information they needed easily; and (c) take steps to attract more visitors to the website by making it more interesting and fruitful.

Based on the results of this research, our recommendations for improving laptop manufacturers' e-commerce websites in terms of enhancing their effectiveness are: (1) making their websites more attractive by having video demonstrations and displays; (2)

placing all related and helpful information on the main-page more directly; (3) applying multi-criteria search capacity to help the potential customers find their desired laptop products more easily; (4) updating the important and necessary information on a more timely fashion; and (5) designing a feedback channel on its website like a "message board" or "forum" to get customers feedback more quickly and more accurately.

Acknowledgements

I would like to express my gratitude to all those who helped me during the writing of this paper. My deepest gratitude goes first and foremost to Professor Zhang, for his instructive advice and useful suggestion on my thesis. Second, I would like to express my heartfelt gratitude to Professor Yang, who helped me a lot with the writing of English. Last my thanks would go to my student-Lingping for analyzing the data for this paper.

References

[1] V. Korner and H. Zimmermann, "Management of customer relationships in business media (MCR-BM)", Electronic Markets, vol. 10, pp. 162-168.
[2] G. L. Geissler, "Building customer relationships online: the web site designers' perspective", Journal of Consumer Marketing, vol. 18, **(2001)**, pp. 488-502.
[3] F. Owen, "China passes U.S. as world's biggest PC market", The Wall Street Journal, vol. 8, **(2011)**, pp. 7-12.
[4] ECOM (Ed.), Electronic commerce -An introduction, http://ecom.fov.unimb.si/center/, Accessed 15.05.1998, **(1998)**.
[5] S. Elliot and S. Fowell, "Expectations versus reality: a snapshot of consumer experiences with internet retailing", International Journal of Information Management, vol. 20, **(2000)**, pp. 323-336.
[6] V. Swaminanthan, E. L. White and B. P. Rao, "Brosers or buyers in cyberspace? An investigation of factors influencing electronic exchange", Journal of Computer-Mediated Communicaiton, vol. 5, no. 2, **(1999)**, pp. 74-80.
[7] D. Thorleuchter and D. Poel, "Predicting e-commerce company success by mining the text of its publicly-accessible website", Expert Systems with Applications, vol. 39, **(2010)**, pp. 13026-13034.
[8] F. Li and Y. Li, "Usability evaluation of e-commerce on B2C websites in China", Advanced in Control Engineering and Information Science, vol. 15, **(2011)**, pp. 5299-5304.
[9] A Salim and B. Abdelmajid, "An evaluation study of the navigation and search systems on two academic websites and Google", The International Information & Library Review, **(2010)**, pp. 50-61.
[10] J. Nielsen, "Designing web usability: The practice of simplicity", Indianapolis, IN:New Riders, **(1999)**.
[11] J. Nielsen and M. Tahir, "Homepage usability: 50 websites deconstructed", Indianapolis, IN: New Riders, **(2001)**.
[12] C. Goi, "A review of web evaluation criteria for e-commerce web sites", Journal of Internet Banking & Commerce, vol. 17, no. 3, **(2012)**, pp. 1-10.
[13] S. Jones and J. Hughes, "Understanding IS evaluation as a complex social process: A case study of a UK local authority", European Journal of Information Systems, vol. 10, no. 1, **(2001)**, pp. 189-203.
[14] V. Serafeimidis and S. Smithson, "Information systems evaluation in practice: A case study of organizational change", Journal of Information Technology, vol. 15, no. 2, **(2000)**, pp. 93-105.
[15] B. Moon, "Consumer adoption of the Internet as an information search and product purchase channel: some research hypotheses", International Journal of Internet Marketing and Advertising, vol. 1, **(2004)**, pp. 104-118.
[16] S. Kim and L. Stoel, "Apparel retailers: website quality dimensions and satisfaction", Journal of Retailing and Consumer Services, vol. 11, no. 2, **(2004)**, pp. 109-117.
[17] V. Davidavičienė and J. Tolvaišas, "Measuring quality of e-commerce web sites: case of Lithuania", Economics & Management, vol. 16, **(2011)**, pp. 723-729.
[18] B. Sohrabi, P. Mahmoudian and I. Raeesi, "A framework for improving e-commerce websites usability using a hybrid genetic algorithm and neural network system", Computing & Applications, vol. 21, no. 5, **(2012)**, pp. 1017-1029.
[19] A. Jowkar and F. Didegah, "Evaluating Iranian newspapers' web sites using correspondence analysis", Library Hi Tech, vol. 28, no. 1, **(2010)**, pp. 119-130.

[20] H. Sun, P. Teh and A. Chiu, "An empirical study on the websites service quality of Hong Kong small businesses", Total Quality Management & Business Excellence, vol. 23, no. 7, **(2012)**, pp. 931-947.
[21] M. Ataei, F. Sereshki, M. Jamshidi and S. E. Jalali, "Suitable mining method for Golbini No. 8 deposit in Jajarm (Iran) using TOPSIS method", Mining Technology: Transactions of the Institute of Mining & Metallurgy, Section A, vol. 117, no. 1, **(2008)**, pp. 1-5.
[22] B. P. Sigman and B. J. Boston, "Digital Discernment: An E-Commerce Web Site Evaluation Tool", Decision Sciences Journal of Innovative Education, vol. 11, no. 1, **(2013)**, pp. 29-46.
[23] C. L. Hwang and K. Yoon, "Multiple attribute decision making methods and applications", Springer-Verlag,Heidelberg, **(1981)**, pp. 3-55.
[24] H. S. Byun and K. H. Lee, "Decision support system for the selection of a rapid prototyping process using the modified TOPSIS method", International Journal of Advanced Manufacturing Technology, vol. 26, **(2005)**, pp. 1338-1347.
[25] Y. Deng, "Plant location selection based on fuzzy TOPSIS", International Journal of Advanced Manufacturing Technology, vol. 28, **(2006)**, pp. 839-844.
[26] F. Ecer, "A new approach towards evaluation and selection of salesperson candidates: fuzzy TOPSIS", Anadolu University Journal of Social Sciences, vol. 7, no. 2, **(2007)**, pp. 187-203.
[27] P. Muralidhar, K. Ravindranath and V. Srihari, "The influence of GRA and TOPSIS for assortment of green supply chain management strategies in Cement industry", International Journal of Supply Chain Management, vol. 2, no. 1, **(2013)**, pp. 49-55.
[28] A. Zeki and G. O. Rifat, "Evaluating machine tool alternatives through modified TOPSIS and alpha-cut based fuzzy ANP", International Journal of Production Economics, vol. 140, no. 2, **(2012)**, pp. 630-636.
[29] L. A. Zadeh, "Fuzzy sets. Information Control", vol. 8, **(1965)**, pp. 338-353.
[30] H. L. Kwang, "First course on fuzzy theory and applications", Springer-Verlag, Berlin-Heidelberg, **(2005)**, pp. 137-144.
[31] C. T. Chen, "Extensions of the TOPSIS for group decision-making under fuzzy environment", Fuzzy Sets and Systems, vol. 114, **(2000)**, pp. 1-9.
[32] G. Isiklar and G. Buyukozkan, "Using a multi-criteria decision making approach to evaluate mobile phone alternatives", Computer Standards and Interfaces, vol. 29, **(2006)**, pp. 265-274.
[33] T. Yang and C. C. Hung, "Multiple-attribute decision-making methods for plant layout design problem", Robotics and Computer-integrated manufacturing, vol. 23, **(2007)**, pp. 126-137.
[34] M. Thelwall, "A comparison of sources of links for academic web impact factor calculations", Journal of Documentation, vol. 58, no. 1, **(2002)**, pp. 66-78.

Authors

Xiaoning Zhu she received her Bachelor degree in Information Systems and Information Management (2006) and PhD in Management Science and Engineering (2011) from University. Now she is lecturer of University of Science and Technology Beijing. Her current research interests include different aspects of e-commerce and e-government affairs.

Qun Zhang. He received his M.Sc in Management (1983) and PhD in Economics (1993) from Aachen University in Germany, used to be the Dean of the School of Economics and Management in University of Science and Technology Beijing, and now is the director of Management Science Research Institute His current research interests include production management and environmental management.

Jiaqin Yang. He is a Professor of Management at the Georgia College & State University, Milledgeville, Georgia, and currently working as a visiting professor at University of Sciences & Technology Beijing, China. He received his Ph.D. in Operations Management from Georgia State University (1988). Dr. Yang's current research interests include: operations strategy, service scheduling, e-business, enterprise development and management.

Lingping Zhang. She is a current master student in School of Economics and Management in University of Science and Technology Beijing. She did some data analysis work in this research. Her current research interests include: e-business, Information system analysis and design.