

Investigating the effect of website quality on e-business success: An analytic hierarchy process (AHP) approach

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Abstract

This study investigates website quality factors, their relative importance in selecting the most preferred website, and the relationship between website preference and financial performance. DeLone and McLean's IS success model extended through applying an analytic hierarchy process is used. A field study with 156 online customers and 34 managers/designers of e-business companies was performed. The study identified different relative importance of each website quality factor and priority of alternative websites across e-business domains and between stakeholders. This study also found that the website with the highest quality produced the highest business performance. The findings of this study provide decision makers of e-business companies with useful insights to enhance their website quality.

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1. Introduction

The importance of evaluating information systems (IS) success has long been recognized by both IS researchers and practitioners [4,16,24,62]. Evaluation is a challenging task because information systems are complex socio-technical entities [54], IS investment is related to intangible benefits and indirect costs [23], and financial data to measure impact of information systems typically are not accumulated [7]. E-business success is no exception and needs careful evaluation.

The decision makers at e-business companies have continued to make vast investments in developing websites for e-business without having clear knowledge of

what factors contribute to developing a high quality website and how to measure effects on e-business success [23,63]. Many researchers are concerned about this issue. For example, DeLone and McLean [17] pointed out that “companies are making large investments in e-business applications but are hard-pressed to evaluate the success of their e-business systems. . . . Researchers have turned their attention to developing, testing, and applying e-business success measures” (p. 24). Similarly, Zhu and Kraemer [73] indicated that “while sizeable investments in e-business are being made, researchers and practitioners are struggling to determine whether and how these expenditures improve the business performance of firms, or even how to measure the Internet-based, e-business initiatives in the first place” (p. 276). Studies reported that less than 5% of customers shopping at physical stores engaged in on-line purchases [8,22]. Therefore, there is an urgent need to help deci-

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sion makers gain a better understanding of online customers' perceptions of more desirable websites [45,70].

This study assumes that the success of an e-business company is more likely when its website is developed to provide the highest level of website quality among alternative websites. This results in online customers selecting a site as the most preferred website. If more customers select the website, the higher the likelihood of improved business performance. The relationship between website quality, preference, and business performance has been proposed by many researchers [11,33,43], but no empirical study has been done. This study addresses this concern, restricting the scope of this study to an investigation of website quality of B2C websites designed for online retail customers.

This study has three sub-objectives. The first is to examine website quality factors (or criteria) and their relative importance in website selection. Using DeLone and McLean's IS success model [17], this study identifies four website quality factors including information quality, system quality, service quality, and vendor-specific quality, which include 14 sub-factors. Then by applying an analytic hierarchy process (AHP) approach [48], this study investigates the relative importance of each factor and ranks alternative websites. AHP has been applied successfully to resolve complex alternative selection problems and more than 1000 AHP articles have been published in refereed journals [21]. The difference between website quality factors and alternative selection in different e-business domains is also examined. The second objective is to identify the perceptual gap between online customers and managers/designers of e-business companies with respect to evaluating website quality and selecting alternative websites. In previous IS development literature [14,60,69], the perceptual gap between users and designers has been recognized as the most critical reason for poor IS development and project failures. By examining this gap, this study can provide insight on managers/designers' misunderstanding of the needs and preferences of online customers and how to address this misunderstanding. Instead of investigating the gap based on a specific theoretical view, this study is an exploratory effort focused on the identification of sources of the gap. The final objective is to investigate the relationship between website preference and business performance. The relationship is tested by comparing the ranking of the most preferred website with that of business performance. The findings of this study responds to the requests of previous researchers to examine the relationship between IS success measures and financial performance [17].

In sum, this study provides useful insights to support the decision making of e-business companies to make strategic and resource allocations for developing high quality websites to improve financial performance.

2. Background

2.1. Evaluating information systems success

During the past decades, companies made large investments in the implementation of information systems with the expectation of productivity gains, competitiveness enhancement, and the reduction of market, administrative and operational costs [40,51]. However, such claims have not been validated by empirical data. Therefore, researchers have made efforts to propose a better way of evaluating information systems. These efforts can be divided into two categories. One is to develop methods for evaluating information systems [24,25,37,57], and the other is to identify factors affecting information system success [16,53], the focus of this study.

Many theoretical models have been proposed for measuring IS success. Out of them, DeLone and McLean's IS success model [16] is the most highly cited. By synthesizing previous IS success models, DeLone and McLean's model demonstrates the interplay of six information systems success factors including information quality, system quality, use, user satisfaction, individual impact, and organizational impact. DeLone and McLean [16] state:

System quality and information quality singularly and jointly affect both Use and User Satisfaction. Additionally, the amount of Use can affect the degree of User Satisfaction—positively or negatively—as well as the reverse being true. Use and User Satisfaction are direct antecedents of Individual Impact; and lastly this impact on individual performance should eventually have some Organizational Impact (pp. 83–87).

The model has been applied successfully to measure the success of a variety of information systems [38,40,53]. Nearly 300 articles in refereed journals have cited the model (Fig. 1) [17].

2.2. Evaluating e-business success

After observing a turbulent e-business environment with the burst of the dot.com bubble, companies realized that e-business is not a magic bullet and a license

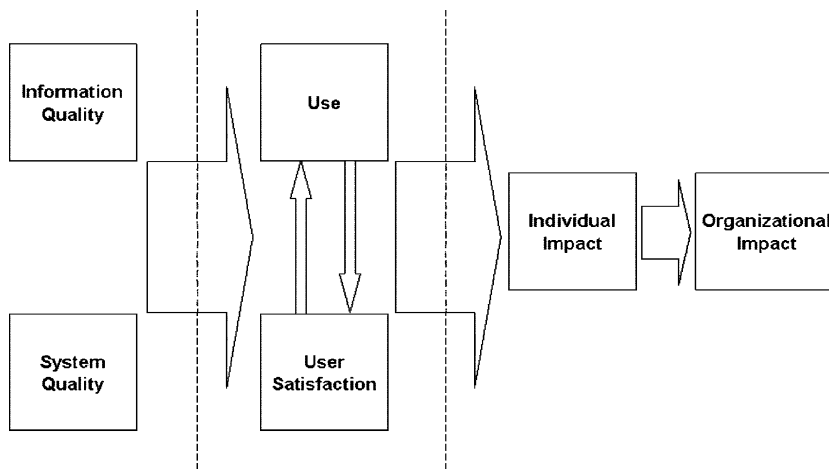


Fig. 1. DeLone and McLean's IS success model.

to print money [9]. Studies [24,42,63] reported that fewer than 25% of dot.com companies last longer than 2 years. Researchers and practitioners put substantial effort in identifying factors affecting e-business success. For example, McKinney et al. [38] proposed a web-customer satisfaction model which includes information quality and system quality and found significant influence on online customer satisfaction. While their study initially identified a large number of information and system quality factors, only a few factors were included in the empirical test by conducting a second-order confirmatory factor analysis. No examination of the relationship between customer satisfaction and business performance was done. Devaraj et al. [18] identified antecedents of B2C channel satisfaction and preference. They found perceived usefulness, ease of use, time, price savings, and reliability were factors affecting B2C channel satisfaction. However, this study has limitations in that (1) it ignores particular characteristics of each e-business domain without des-

ignating target websites; and (2) most of SERVQUAL constructs were found not to be significant, which is contrary to the findings of other studies [32]. Torkzadeh and Dhillon [64] proposed means and fundamental objectives that influence e-business success. As a result, five means including Internet product choice, online payment, Internet vendor trust, shopping travel, and Internet shipping errors, and four fundamental objectives including Internet shopping convenience, Internet ecology, Internet customer relation, and Internet product value were found. While the objectives are intuitively believed to significantly influence e-business success, there was no validation of how these objectives are related to e-business success measures. Zhu and Kraemer [73] developed four e-business capability matrixes including information, transaction, customization, and supplier connection, and found significant relationships between these four matrixes and firm performance in 260 manufacturing companies. However, this study identified only firm-level objective ma-

Table 1
Summarized results of previous e-business success models

References	Factors of website quality (or e-commerce success)
Argawal and Venkatesh [2]	Content, ease of use, promotion, made-for-the-medium, emotion
Barnes and Vidgen [6]	Usability, design, information, trust, empathy
Devaraj et al. [18]	Usefulness, ease of use, time, asset specificity, uncertainty, price savings, empathy, reliability, responsiveness, assurance
Koufaris [30]	Perceived control, shopping enjoyment, concentration, perceived usefulness, perceived ease of use
Liu and Arnett [32]	Quality of information and service, system use, playfulness, system design quality
Loiacono et al. [34]	Ease of use, usefulness, entertainment, complementary relationship
Plamer [45]	Download delay, navigation/organization, interactivity, responsiveness, information/content
Schubert [50]	Information phase, agreement phase, settlement phase, after-sales, community components
Webb and Webb [67]	Reliability, assured empathy, tangibility, navigability, relevant representation, accuracy, security, trustworthiness, perceived usability
Wu et al. [70]	Information content, cognitive outcomes, enjoyment, privacy, user empowerment, visual appearance, technical support, navigation, organization of information, credibility, impartiality

Table 2
Pairwise comparisons of evaluation criteria

	Size of house	Transportation	Neighborhood	Age of house	Yard space	Modern facilities	General condition	Financing	Priority vector
Size of house	1	5	3	7	6	6	1/3	1/4	0.173
Transportation	1/5	1	1/3	5	3	3	1/5	1/7	0.054
Neighborhood	1/3	3	1	6	3	4	6	1/5	0.188
Age of house	1/7	1/5	1/6	1	1/3	1/4	1/7	1/8	0.018
Yard space	1/6	1/3	1/3	3	1	1/2	1/5	1/6	0.031
Modern facilities	1/6	1/3	1/4	4	2	1	1/5	1/6	0.036
General condition	3	5	1/6	7	5	5	1	1/2	0.167
Financing	4	7	5	8	6	6	2	1	0.333

1: equal importance, 3: moderate importance of one over another, 5: essential or strong importance, 7: very strong importance, 9: extreme importance, 2, 4, 6, 8 are intermediate values between the two adjacent judgments. Reciprocals: if criteria i has one of the above numbers assigned to it when compared with criteria j , then j has the reciprocal value when compared with i .

trixes, not customer-level perceptual matrixes. Measuring website quality is not intrinsically objective in nature, but rather is closely related to online customers' subjective perception of a website through interaction with the site [2,26,27,71].

As shown in Table 1, several studies have been conducted to identify factors affecting e-business success. They have made significant contributions to provide a richer understanding of the effect of website quality factors on e-business success, but there is still much room left for exploration both in terms of extending the current models by (1) augmenting with more factors affecting e-business success, (2) examining perceptual gaps between managers/designers and customers, and (3) investigating the relation between these factors and e-business performance.¹

2.3. Analytic hierarchy process

The analytic hierarchy process is a multi-criteria decision-making method allowing decision makers to model a complex problem in a hierarchical structure which consists of the goal, objectives (criteria), sub-objectives, and alternatives [48]. Based on pairwise comparison judgments, AHP integrates both criteria importance and alternative preference measures into a single overall score for ranking decision alternatives [43]. AHP provides an overarching view of the complex relationships inherent in the problem and helps the decision maker assess whether the evaluation criteria are of the same order of magnitude, so the decision maker can compare such homogeneous alternatives accurately.

¹ Conducting multiple studies in a paper is a challenging task, but we believe that it is worthwhile as an exploratory study to provide a cornerstone for conducting future studies in this area.

AHP consists of three principles of decomposition, comparative judgment, and priority synthesis [48]. *Decomposition* is related to the construction of a hierarchical structure of the model to present the problem. The highest level represents the overall objective; the middle level represents evaluation criteria; and the lowest level represents decision alternatives. *Comparative judgment* is a pairwise comparison of the factors at the same level for measuring their comparative contribution to the overall objective. A comparison matrix is developed by comparing pairs of criteria or alternatives. The pairwise comparison helps decision-makers to judge independently the contribution of each criterion to the objective. Finally, *priority synthesis* computes a composite weight for each alternative, based on preferences identified through the comparison matrix. Based on the value of composite weight, relative priority of each alternative can be obtained. A sensitivity analysis is followed to show how criteria weighting changes can affect the changes of ranks of alternatives. The consistency of the results is measured using a consistency ratio (CR).² A CR of less than 10% is considered adequate to interpret the results [11]. The detailed processes to apply the AHP method are described below.

For example, a problem might be “what house to buy?”³ The first step to select the best alternative is to formulate a hierarchy. The first level of the hierarchy is used to define the overall goal, which is to identify the house to provide the most satisfaction. The second level

² For a pairwise comparison matrix $A=(a_{ij})$, if it is consistent, then $a_{ij}=a_{ik}a_{kj}$, then the ratio-scale components of the right eigenvector give the true, actual priorities of the items being compared. Saaty [48] showed how to calculate the inconsistency of a comparison matrix, with a 10% error being the suggested acceptable limit.

³ The example is developed based on Saaty's tutorial of the AHP method [48].

Table 3
Pairwise comparisons of alternatives with respect to size of house and transportation

	A	B	C	Priority vector
<i>(a) Size of house</i>				
A	1	6	8	0.754
B	1/6	1	4	0.181
C	1/8	1/4	1	0.065
<i>(b) Transportation</i>				
A	1	7	1/5	0.233
B	1/7	1	1/8	0.005
C	5	8	1	0.713

of the hierarchy is to determine the evaluation criteria. Let us assume that it has been known that 8 major criteria affect house purchases. They are size of house, transportation, neighborhood, age of house, yard space, modern facilities, general condition, and financing. The third level of the hierarchy is used to identify alternatives. There are three alternative houses (A, B, and C) in this case.

The second step is to elicit pairwise comparison judgments. After arranging the evaluation criteria into a matrix, judgments about their relative importance with respect to the overall goal are elicited by asking questions that compare one criterion with the other (see Table 2). For example, regarding size of house and transportation, it is necessary to determine which is considered more important by the family buying the house to maximize its satisfaction. An example matrix of pairwise comparisons of the criteria given by the house buyers is shown in Table 2.

Next pairwise comparisons of the alternatives at the lowest level are determined. Each alternative is compared pairwise with respect to how much better one is than the other in satisfying each evaluation criteria of the second level of the AHP hierarchy. Examples of matrices of comparisons of alternative houses and their local priorities are shown in Table 3.

The final step is to establish the global priorities (so-called “normalized priority weights”) of the houses to identify the best alternative. By laying out the local priorities of the house with respect to each criterion in a matrix and multiplying each column of vectors by the priority of the corresponding criterion and adding across each row results in the global priorities of the houses as shown in Table 4.⁴

⁴ Research subjects participated in this study by answering questions regarding pairwise comparisons.

Based on the global priority, alternative C can be chosen as the best house to buy⁵. AHP has been known to enhance the evaluation, choice, and resource allocation phase of decision making. That is, AHP effectively measures the relative impact of factors affecting possible outcomes, and in doing so, predicts outcomes. The predictions then are useful inputs for evaluating alternative courses of action. AHP has been applied successfully to resolve various IS problems such as project selection [13], diagnostic technology [11], manufacturing systems [55], and telecommunication systems vendors [61], but has not been widely applied to e-business areas. Only a few studies (e.g., [43,49]) have been conducted.

3. Research model

Recently DeLone and McLean [17] proposed an updated model augmented with new information systems success factors (e.g., service quality, intention to use, net benefits). They pointed out the applicability of the new model to measure e-business success and requested its empirical validation. Based on the updated model and literature on user satisfaction, service quality and vendor selection, this study proposes a research model for selecting a most preferred website (see Fig. 2).⁶ The model consists of four major website quality factors including information quality, service quality, systems quality, and vendor-specific quality. We believe the four website quality factors significantly influence website selection and the most preferred website will generate the highest business performance. The detailed discussion on each quality factor follows.

3.1. Information quality

Information quality, the quality of the information that the system produces and delivers, is considered to be a key factor affecting IS success. In the e-business

⁵ Many studies (e.g., [11,48]) described a mathematical model of the AHP method.

⁶ Based on an extensive literature review and interviews with 11 experienced online customers, the hierarchical structure consisting of evaluation factors and alternative websites was developed. Four website quality factors and their 14 sub-factors were identified to evaluate the most preferred website. Two types of e-business sites including four online electronics websites and four online travel websites were selected as target websites. They were selected by asking the interviewees to list the top five online travel websites and top five online electronics websites. Based on that input, four highly ranked online travel websites and four online electronics websites were selected. All of these websites were highly ranked in Alaxa.com with respect to the number of daily visitors.

Table 4
Global priorities to identify the best alternative

	Size of house	Transportation	Neighborhood	Age of house	Yard space	Modern facilities	General condition	Financing	Global priority
A	0.173	0.054	0.188	0.018	0.031	0.036	0.167	0.333	0.396
B	0.754	0.233	0.754	0.333	0.674	0.747	0.200	0.072	0.341
C	0.181	0.055	0.065	0.333	0.101	0.060	0.400	0.650	0.263
	0.065	0.713	0.181	0.333	0.226	0.193	0.400	0.278	0.263

context, website information quality insinuates delivering relevant, updated, and easy-to-understand information to significantly influence online customers' attitude, satisfaction, and purchases [20]. It is proposed that the higher the quality of the website information, the more online customers would select that website for online shopping.

Information quality can be measured using information relevance, currency, and understandability. Information *relevance* includes relevant depth and scope, and completeness of the information. *Currency* includes updating of the information. *Understandability* includes ease of understanding and clearness of the information. The significant effects of information relevance [19], currency [38] and understandability [44] on increasing information quality were exhibited in previous studies.

3.2. Service quality

Service quality refers to the overall support delivered by the Internet retailers. Service quality becomes more

critical in e-business since online customers transact with unseen retailers [15]. To provide better service, retailers implement several service functions into the website such as 24 × 7 services, FAQs, online delivery tracking systems, and complaint management systems.

SERVQUAL is a well-known instrument to measure customers' expectation and perception of service quality. While there are some issues with its gap assessment process [65], SERVQUAL has been adopted successfully in the IS field to measure IS service quality [31,66]. SERVQUAL consists of reliability, responsiveness, empathy, assurance, and tangibility. Reliability, responsiveness, and empathy are applicable to measure e-business service quality. *Reliability* refers to the ability to perform the promised service dependably and accurately; *responsiveness* refers to the willingness to help online customers and provide prompt service; and *empathy* refers to the caring and attention the online retailer provides its customers. While *tangibility*, appearance of physical facilities, equipment, personnel, and communication materials, is one of SERVQUAL measures, it was not included since it fits with a phys-

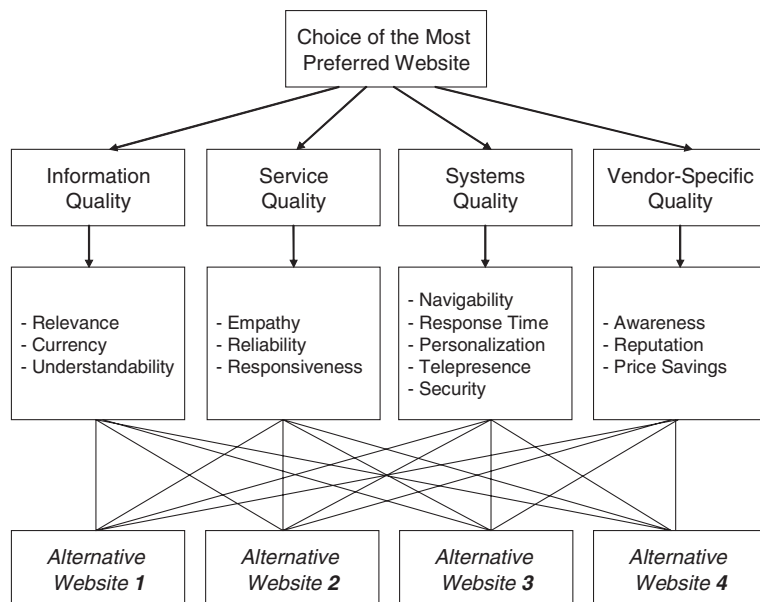


Fig. 2. Research model of analytic hierarchy.

ical store context, not with online stores⁷. We also did not include *assurance* since it was found to have a high correlation with *empathy*⁸ [18].

3.3. System quality

System quality, defined as system performance in delivering information, also has been recognized as a critical success factor influencing technology use and user satisfaction [16]. In the e-business context, website system quality has been known to have a significant effect on online customer satisfaction [45] and online purchases [2,3]. Customers dissatisfied with websites characterized by poor navigation, slowness, non-vividness, being unsecured, and with no personalized services are likely to leave the site even though the information provided by the website is of high quality [38].

System quality can be measured using navigability, response time, personalization, telepresence, and security. *Navigability* refers to the website's capability to provide alternative interaction and navigating techniques [15]. *Navigability* provides online users more control in navigation, and helps reach the target web page with less disorientation [56]. *Fast response time* is important to increase system quality since online users are unwilling to wait more than a few seconds for a response [47]. With heavy information overload experienced by online customers to find and select the best product or services, there has been substantial demand for *personalized systems* to treat each customer individually [46,72]. Personalization systems could provide online customers an individualized interface, effective one-to-one information, and customized service [41,52]. *Telepresence* refers to sense of reality in a virtual environment created by a computer/communication medium [59]. Online consumers are known to want to feel and touch the products, and communicate with retailers like in physical markets. They are inclined to use their real-world experience as a standard for assessing their online experience [29,35]. Finally, *security* is one of the biggest obstacles to e-business. Online consumers do not disclose their personal and financial information until they are convinced the website is secure. Thus websites should implement multiple features (e.g., encryption, third-party affiliations, security statement) to assure secure online shopping [28].

⁷ In addition, since the concept of tangibility overlaps with telepresence with respect to vividness and interactivity, we decided not to include it.

⁸ Because the research design does not allow participants to go beyond the after purchase stage, assurance could not be reasonably measured.

3.4. Vendor-specific quality

Along with the three website quality factors discussed above, Internet vendor-specific quality, the awareness of Internet vendors and their reputation and price competitiveness, also has been considered an important e-business success factor.

E-business companies spend millions of dollars on advertising to increase awareness of their online presence since website *awareness* is directly related to brand loyalty and network effects [1]. Awareness of the website is increased when a critical mass who know and want to experience the website exists. Previous studies [36] have found that users prefer to select technology that has been selected by a large number of other users. *Price savings* has been considered a measure of store efficiency [5,68] since an efficient store could lower the cost of trading and thus customers get better prices. Price savings have been found to have a significant effect on online purchases. This is especially true within the domain of B2C companies using a cost-focus strategy and selling commodity items such as an electronic device or airline ticket where each vendor has the exact same product. For example, Devaraj et al. [18] found that price savings significantly influence satisfaction with the e-business channel in purchasing books or CDs on the Internet. Chen and Dubinsky [12] demonstrated the negative effect of high product price and perceived customer value on online purchases. Finally, a retailer's *reputation* is a key measure of vendor-specific quality. Economists [39,58] have found that reputation and price have a positive relation, noting that customers have greater proclivity to pay more to retailers with a high-reputation.

4. Research methods

A questionnaire-based field survey was conducted to investigate the relative importance of website quality factors on online customers and managers/designers of e-business companies with respect to selecting the most preferred website. The criteria and their measurement items were initially developed based on a literature review.⁹ Then, by conducting interviews with 11 experts including six faculty members and five business doctoral students, the wording, content, and format of the questionnaire were modified.

Two groups of participants were recruited including 156 online customers and 34 managers/designers of

⁹ Alternative sites were selected during the research model development phase.

Table 5
Demographic information

	Online customers		Managers/designers	
	Online electronics (<i>n</i> =69)		Online travel (<i>n</i> =72)	
Age	Below 20	1	Below 20	2
	20–25	28	20~25	31
	25–30	24	25~30	24
	30–35	10	30~35	11
	Over 35	6	Over 35	4
No. of online purchases	4.7		3.2	
No. of purchases at different stores	2.5		2.3	
Gender	62% Male		56% Male	
	38% Female		44% Female	
Internet use	7.43 years		7.67 years	
	Major			
	Engineering	11	Engineering	15
	Arts and sciences	16	Arts and sciences	12
	Business	34	Business	40
	Others	8	Others	5

e-business companies¹⁰ (see Table 5). The former group consisted of business major undergraduate and graduate students who had taken an electronic commerce class in a Western university¹¹. Of the 156 online customers, eighty who had on average of 3.2 online travel product purchases (e.g., airline tickets, hotels, rental cars) from an average of 2.3 different online travel websites in the past 3 years were recruited for a survey of online travel websites. The remaining 76 with an average of 4.7 online electronics purchases (e.g., mp3 player, cellular phone, CDs, games) from an average of 2.5 different online electronics websites were selected for a survey of online electronics websites.

Before answering a questionnaire, each subject was first required to navigate two websites (one an online electronics and the other an online travel) and conduct tasks based on a given online purchasing scenario.¹² Then each subject filled out a questionnaire containing questions of relative weight of one criterion over another. Finally, the subjects visited all target websites and answered questions related to relative strength of each alternative website in each criterion.¹³ Approximately 2 h were taken to complete the participation. Participation was voluntary and compensated with a

class point (3% of total class points) and entry in a sweepstake.

The group of 34 managers/designers participated in an e-business seminar (website design) hosted by the same university. Most of them worked at small local website development companies as both a manager and designer. As a part of the seminar, they were requested to perform an online travel website selection task, the same task as the online customers, and complete a questionnaire. This group had on average of 4.6 online purchase experiences from an average of 2.4 different online travel websites. As a result, a total of 141 usable customer responses (69 from online travel, 72 from online electronics) and a total of 32 responses from managers/designers were gathered. The average age of online customers was 26.7 years old, and that of managers/designers was 32.4 years old. The gender was somewhat balanced with 41% and 33% females respectively.

5. Results

The data were analyzed using Expert Choice, an application implementing the analytic hierarchy process. Expert Choice provides results including local and global weights, priorities for the alternatives, and sensitivity analysis.

5.1. Comparison of the evaluation factors

The importance of each factor with respect to contributing to the preferred website selection was examined first. Pairwise comparisons were conducted to obtain the relative importance of each factor. Fig. 3 shows a graphical plot of the weights.

¹⁰ Although 34 managers/designers are relatively small for conducting covariance-based statistical analysis (i.e. structural equation model), it was necessary to apply the AHP method. Less than 10% consistency ratios for each criterion supports that the sample size is appropriate.

¹¹ 81% of the students who are taking class were from non-IS majors, and 48% of them are from outside the business school. Therefore, the study sample was not restricted to a group of technology-savvy and business major subjects.

¹² A sample scenario is attached in Appendix A.

¹³ Sample questions are attached in Appendix B.

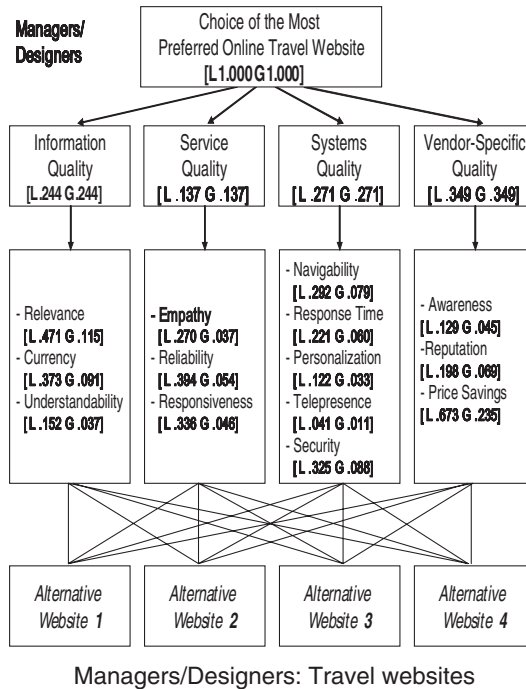
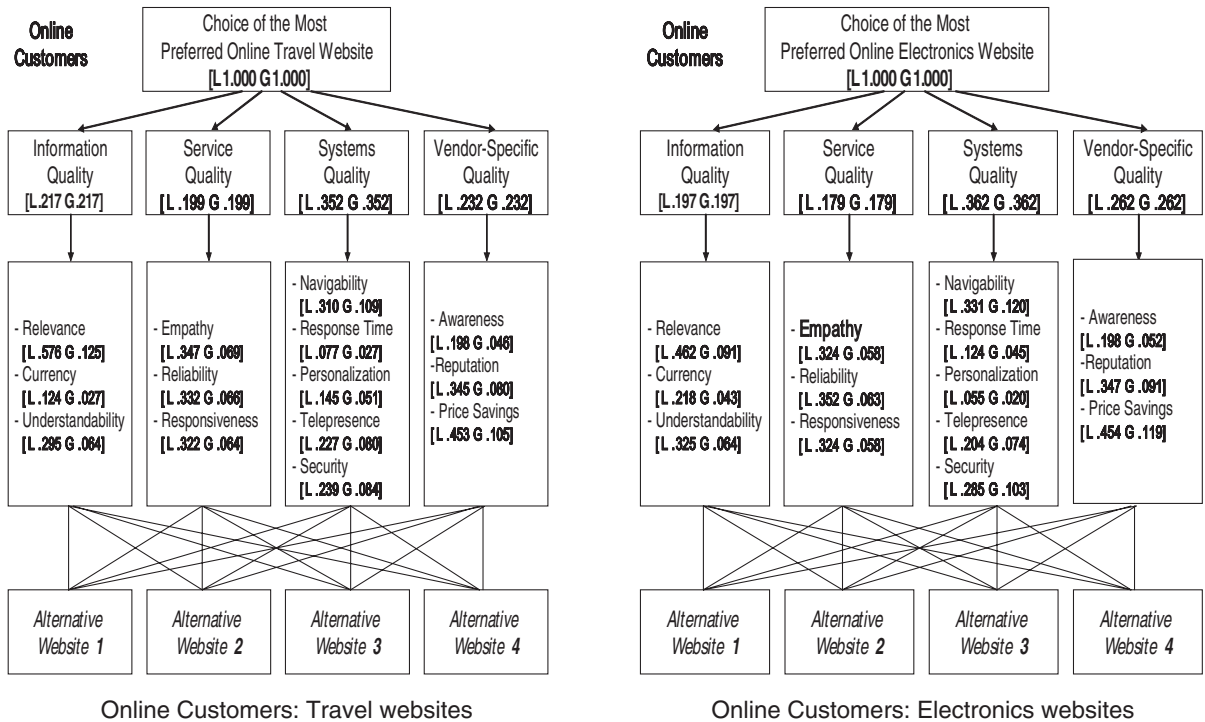


Fig. 3. Relative importance of the evaluation factors.

For online customers using online travel websites, *systems quality* had the highest weight of 0.352, followed by *vendor-specific quality* (0.232) and *information quality* (0.217). Similar results were found in

online electronics websites. *Systems quality* had the highest weight of 0.362, followed by *vendor-specific quality* (0.262) and *information quality* (0.197). *Service quality* had relative weights of 0.199 (online travel)

Table 6
Ranking of website quality factors

	Online customers				Managers/designers	
	Online travel		Online electronics		Online travel	
	Global weights	Rank	Global weights	Rank	Global weights	Rank
Info. relevance	0.125	1	0.091	4	0.115	2
Navigability	0.109	2	0.120	1	0.079	5
Price savings	0.105	3	0.119	2	0.235	1
Security	0.084	4	0.103	3	0.088	4
Telepresence	0.080	5	0.074	6	0.011	14
Reputation	0.080	5	0.091	4	0.069	6
Empathy	0.069	7	0.058	9	0.037	11
Reliability	0.066	8	0.063	8	0.054	8
Understandability	0.064	9	0.064	7	0.037	11
Responsiveness	0.064	9	0.058	10	0.046	9
Personalization	0.051	11	0.020	14	0.033	13
Awareness	0.046	12	0.058	10	0.045	10
Currency	0.027	13	0.043	13	0.091	3
Response time	0.027	13	0.045	12	0.06	7

and 0.179 (online electronics), which was relatively unimportant.

Compared to online customers, managers/designers considered *vendor-specific quality* (0.349) as most important when they chose online travel websites, followed by *system quality* (0.271), and *information quality* (0.244). Like online customers, *service quality* (0.137) was found to be comparatively unimportant.

Table 6 shows a ranked comparison of website quality factors between online customers and managers/designers. For online customers, information relevance, navigability, price savings, security, telepresence and reputation were the top website quality factors. As shown in the table, ranking differences of those factors between online travel and online electronics websites were found.

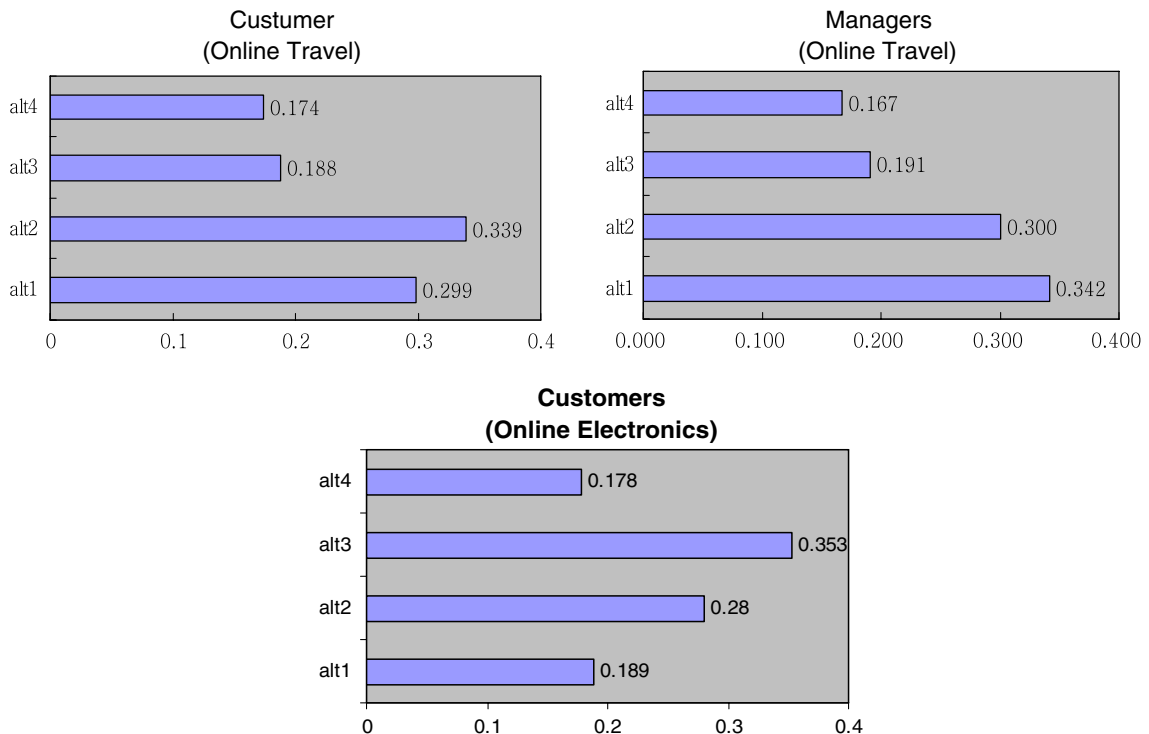


Fig. 4. Results of alternative website preferences.

Table 7
Normalized priority weights for website quality factors

	Online customers								Managers/designers			
	Online travel				Online electronics				Online travel			
	Alt1	Alt2	Alt3	Alt4	Alt1	Alt2	Alt3	Alt4	Alt1	Alt2	Alt3	Alt4
Relevance	0.520	0.408	0.064	0.008	0.165	0.286	0.226	0.165	0.522	0.409	0.061	0.009
Currency	0.148	0.222	0.222	0.407	1.860	0.326	0.256	0.233	0.374	0.209	0.275	0.143
Understandability	0.281	0.391	0.172	0.172	0.063	0.531	0.375	0.047	0.270	0.405	0.162	0.162
Navigability	0.330	0.367	0.165	0.147	0.033	0.242	0.675	0.050	0.443	0.392	0.089	0.076
Response time	0.259	0.296	0.222	0.259	0.133	0.244	0.400	0.222	0.583	0.517	0.117	0.100
Personalization	0.250	0.298	0.250	0.214	0.200	0.250	0.400	0.150	0.242	0.303	0.242	0.212
Telepresence	0.373	0.216	0.235	0.196	0.149	0.311	0.365	0.176	0.364	0.182	0.273	0.182
Security	0.288	0.338	0.238	0.138	0.194	0.262	0.408	0.136	0.318	0.295	0.239	0.136
Empathy	0.217	0.536	0.101	0.145	0.065	0.210	0.613	0.113	0.378	0.351	0.081	0.189
Reliability	0.348	0.318	0.076	0.273	0.333	0.300	0.250	0.117	0.352	0.315	0.074	0.259
Responsiveness	0.281	0.203	0.219	0.297	0.259	0.276	0.207	0.259	0.283	0.196	0.217	0.304
Awareness	0.326	0.326	0.130	0.196	0.135	0.346	0.327	0.192	0.333	0.333	0.133	0.200
Reputation	0.275	0.425	0.163	0.150	0.198	0.253	0.308	0.231	0.275	0.420	0.159	0.145
Price savings	0.210	0.343	0.210	0.248	0.269	0.202	0.328	0.210	0.332	0.247	0.251	0.174
Priority	0.299	0.339	0.188	0.174	0.189	0.280	0.353	0.178	0.342	0.300	0.191	0.167
Ranking	2	1	3	4	3	2	1	4	1	2	3	4

For managers/designers, price savings, information relevance, currency, security, and navigability are the top 5 website quality factors. The table also shows in bold significant perceptual gaps of relative importance of website quality factors between online customers and managers/designers, especially on telepresence, currency, and response time.

The overall consistency of the input judgment at all levels was 0.01 (online customers: online travel), 0.03 (online customers: online electronics) and 0.03 (managers/designers: online travel), within the acceptable threshold value of 0.1 (Saaty, 1990).

5.2. Comparisons of alternative websites

Fig. 4 shows the overall priority of website alternatives.

For online customers, out of four online travel websites, alt2 (0.339) was found to be the most preferred choice, followed by alt1 (0.299), alt3 (0.188), and alt4 (0.174). For managers/designers, alt4 (0.342) was the most preferred, followed by alt2 (0.300), alt3 (0.191), and alt4 (0.167). The results showed that the most preferred online travel site of online customers (alt2) was different from that of managers/designers (alt1). In online electronics websites, alt3 (0.353) was the most preferred website followed by alt2 (0.280), alt1 (0.189), and alt4 (0.178).

Table 7 shows the normalized priority weights which help identify the most preferred website for each criterion. For example, for online customers, the most preferred online travel website (alt2) was found to have the

highest understandability, navigability, response time, security, empathy, reputation, and price savings, while the second most preferred website (alt1) had the highest information relevance, telepresence, reliability, and awareness. In addition, the most preferred online electronics website (alt3) had the highest navigability, response time, personalization, telepresence, security, empathy, reputation, and price savings, while the second most preferred website (alt2) had the highest relevance, currency, understandability, and responsiveness. The result indicates that online customers have different preferences for the same website quality factors as the type of website changes. This provides empirical support for the value of website personalization.

For managers/designers, the most preferred online travel site (alt1) was found to have the highest relevance, currency, navigability, telepresence, security, empathy, reliability, and price savings, while the second preferred website (alt2) was found to have the highest understandability, personalization, and awareness.¹⁴

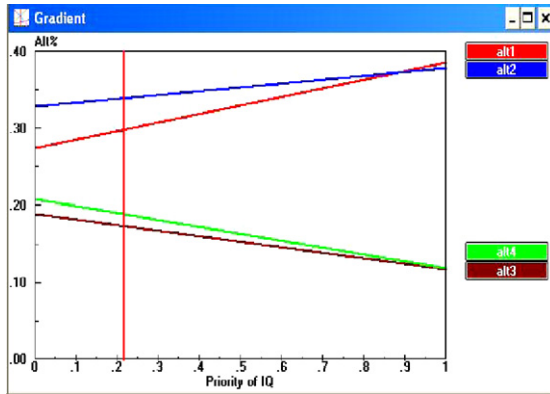
There are several interesting findings of perceptual differences between customers and managers/designers. First, with respect to currency, customers perceived alt 4 as the most current website, while managers/designers

¹⁴ Although Alt 4 is a widely known website, it only showed strengths related to currency and responsiveness over others. One possible reason is that the website has a relatively shorter history than the others and has not evolved in design as much as the others. The fact that financial performance of the company is inferior to others empirically supports the effect of its immature design and reputation.

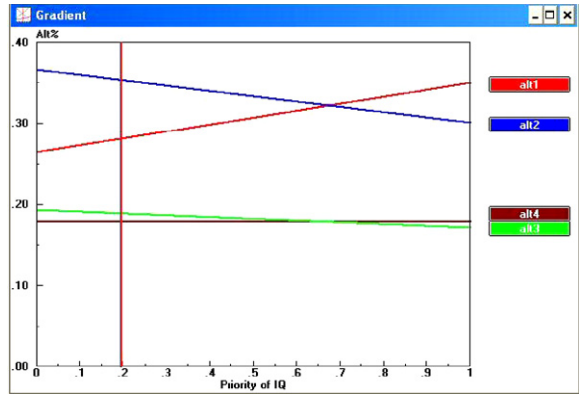
chose alt1, which was perceived as the least current website by the customers. This is a surprising finding, noting that the effort of managers/designers to update their websites was not visually apparent and thus customers did not catch the updates. Including the last update information (e.g., date/time information of the

last update at the bottom of the page) and placing the update information at the most front and center of the homepage could be a possible design alternative.

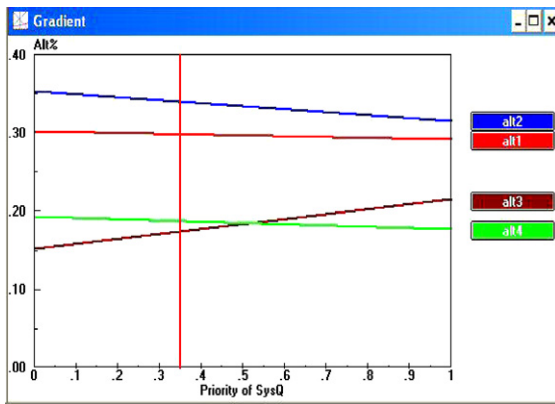
Second, response time is another criterion providing a significant perceptual difference between customers and managers/designers. While customers did not clearly



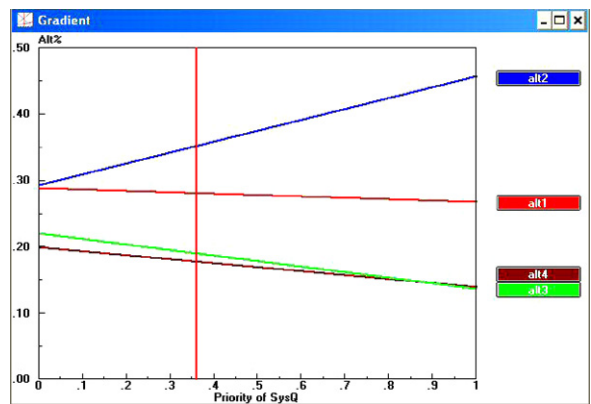
Info Quality-Online Customer/OnlineTravel



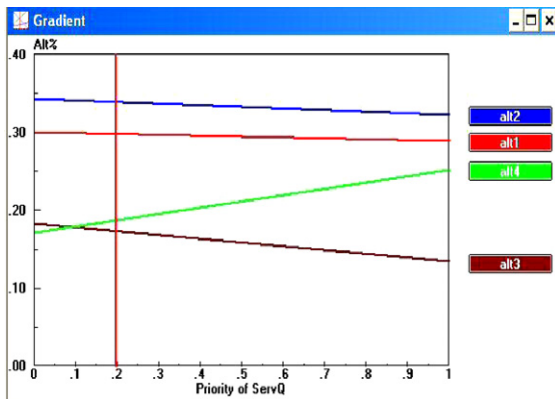
Info Quality-Online Customer/Online Electronics



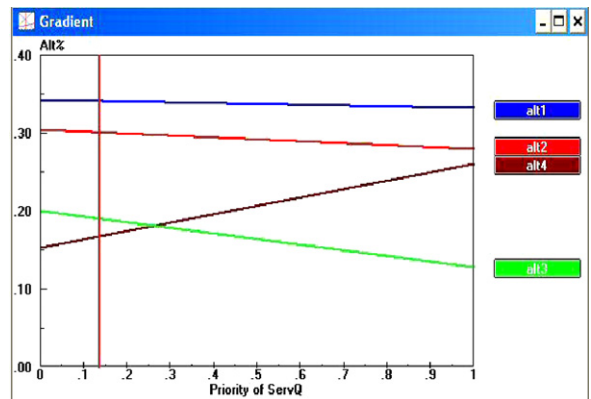
SYSQ-Online Customer/OnlineTravel



SYSQ-Online Customer/Online Electronics



SERQ-Online Customer/Online Travel



SERQ-Managers-Designers/Online Travel

Fig. 5. Results of sensitivity analysis.

Table 8
Comparison of ranking of website preference and business performance

	Online travel				Online electronics			
	Alt1	Alt2	Alt3	Alt4	Alt1	Alt2	Alt3	Alt4
Website preference	2	1	3	4	3	2	1	4
Business performance: ROA	0.077	0.092	0.067	0.064	0.122	0.201	0.254	0.071
Business performance: ROE	0.136	0.139	0.110	0.114	0.201	0.354	0.424	0.176
Business performance: PM	0.661	0.709	0.031	0.034	0.099	0.359	0.079	0.080

find the differences of response time across alternative websites, managers/designers clearly distinguish alt1 and alt2 from alt3 and alt4. This indicated that that customers perceive response time differently from managers. During the debriefing interviews with several online customers and managers/designers, this turned out to be the case. Assuming that shopping cart abandonment is a serious problem, managers/designers spend most of their efforts to speed up check-out processes. Yet, customers perceived response time as the time to get the result screen after clicking the submit button.

Third, a perceptual difference of price savings was found. One possible interpretation is that while managers/designers calculate price savings by adding product sales price and tax to the average shipping costs, customers calculate it mainly based on the product sales price. That is, customers consider shipping costs as a choice of delivery options, while managers/designers consider it as a part of total price. While the study of pricing decisions is out of the scope of this study, managers/designers might adjust their pricing strategy by considering the findings of this study.

Finally, from an overall perspective, customers selected alt2 as their best choice, while managers/designers selected alt1 as their most preferred website. This finding indicates that managers/designers might modify their priorities of website quality factors to meet customers' priorities, helping them make the right resource allocation decision for maximizing business performance.

5.3. Sensitivity analysis

Sensitivity analysis investigates the impact of a change in input data or parameters of proposed solutions. The result provides online retailers with useful information of how to improve website quality to catch up with a competitor or how to maintain superiority as the most preferred website. Expert Choice automatically conducted a sensitivity analysis and provides the result as shown in Fig. 5. The figure shows how the weights for alternative websites vary when the weight for each of the four major website quality factors is varied from 0 to 1. The results

of the sensitivity analysis suggested that information quality (IQ) for online customers may cause the best alternative site (alt2) to switch its rank with the second best alternative site (alt1) when the weight of the factor is greater than 0.876 (online travel) and 0.674 (online electronics).¹⁵ It implies that the rank of alt 1 could possibly change into the top rank if alt1 invests significant amount of efforts to enhance information quality. The figure also shows that system quality (SYSQ) and service quality (SERQ) for online customers, and service quality for managers/designers might alter the rank of alt3 and alt4 when the weight of the factor is greater than 0.541, 0.895, 0.09, and 0.265 respectively.

5.4. Comparisons of website preference and business performance

To validate whether the most preferred website produces the highest business performance, this study compared the ranking of website preference with that of actual business performance. Although a preliminary effort, this comparison is included to exhibit that this type of analysis is valuable. Data for this analysis was obtained from COMPUSTAT and target companies. Business performance for each alternative website was measured by return on assets (ROA) and return on equity (ROE) in fiscal year 2003 for online travel websites and in fiscal years 2000–2004 for online electronics websites. Since one online travel did not publicly open its books until 2003, the profit margin (PM= gross earnings/sales) was calculated using year 2004 data. The formula for ROA and ROE is:

$$\begin{aligned} \text{ROA} &= \left(\sum_i \frac{\text{net_income}_i}{\text{total_asset}_i} \right) / i, \text{ ROE} \\ &= \left(\sum_i \frac{\text{net_income}_i}{\text{shareholder's equity}_i} \right) / i = \# \text{ of years} \end{aligned}$$

¹⁵ 0.876 and 0.674 represent the absolute value changes of each criterion necessary to cause the reversal of rank of an alternative.

As shown in Table 8, the ranking of website preference matched with that of business performance, except for the third and fourth ranked online travel websites.

6. Discussion and conclusion

By adopting DeLone and McLean's IS success model and applying an AHP method, this study investigated factors affecting website selection, the factors' relative importance, and the priority of alternative websites. The study then validated the relationship between website preference and business performance.

This study does have limitations that should be revisited in future studies. First, the B2C websites of two e-business domains used in the study might not represent all e-business domains. Second, this study only includes websites that sell commodity goods, not unique goods. Third, this study was conducted with relatively small samples, especially for managers/designers of small web design companies. This may have caused a sample selection bias problem. Third, since the study is based on the AHP method, measurement instruments for each criterion were not developed. Future studies using different statistical methods (e.g., regression, structural equation modeling) to develop the instruments are recommended. Fourth, since e-business websites were selected as target websites, researchers have no control over them. This does not allow investigation of the effects of each criterion under a controlled environment. Fifth, evaluation criteria were selected within the boundary of DeLone and McLean's model, which could have excluded some criteria that might strongly influence website quality. Sixth, this study was conducted under a simulated purchasing environment, not an actual purchasing one, which might result in a lower weight for service quality. Finally, measuring financial performance using a short-term time period may introduce inaccuracy problems.

Despite the limitations, the analyses showed several interesting results. First, the study found that each of the four website quality factors were relevant criteria in selecting the most preferred website. Online customers considered system quality as the most important factor. Navigability and security were highly ranked, indicating that companies should expend more effort to make the website more navigable and safe. Vendor-specific quality also was highly pertinent. Both reputation and price savings got attention from online customers noting that companies should deploy a balanced strategy of increasing reputation and re-

ducing price. The relative unimportance of service quality was a surprising finding. One possible reason is that online customers have experienced poor web service and they may not be familiar with newly implemented service quality features (e.g., online complaint management systems). However, this does not mean service quality is less important. Instead, e-business companies might use high service quality as a strategic tool for business differentiation from other competitors.

Second, this study found that online customers perceived different importance of website quality factors in different e-business domains. While the top ranked website quality factors were similar, the ranking order was different. For example, in an online travel domain, information relevance was the most important factor, while navigation was the most important factor in an online electronic domain. The result is similar to a recent finding in marketing literature [10] asserting that customers' importance varies depending on the types of product, technology, or services. Therefore, the findings of this study are effective only for online electronics and travel domains, not all e-business domains. Further study to reveal the relative importance of website quality factors in a particular e-business domain is recommended.

Third, this study identified several perceptual gaps existing between online customers and managers/designers. First, while managers/designers considered price as the most important factor for selecting the most preferred online travel site, online customers considered information relevance and navigability as most important. This indicates that compared to managers/designers' expectations, online customers achieved satisfaction while engaging in online purchases rather than in direct financial benefits. In addition, there was a significant perceptual gap on telepresence. That is, while online customers preferred to have a vivid and interactive experience from an online store, managers/designers consider it the least important factor. Managers/designers may ignore online customers' aesthetic values for online shopping. The findings of these perceptual gaps suggest that managers/designers should design the website providing more aesthetic and convenient shopping experiences. Given the existence of the perceptual gap, future studies that reveal the causal links related to the perceptual gaps based on theoretical models are desirable.

Finally, this study demonstrated the positive relationship between website preference and business performance by showing that the ranking of the most

preferred website was matched with that of the highest performing websites. While the finding has a limitation from using short-term financial data to measure business performance, the attempt to investigate the relationship between an e-business success factor and business performance is of value.

This study does provide several theoretical and practical implications. From a theoretical perspective, this study empirically validated that DeLone and McLean's IS success model could successfully explain e-business success. In addition, this study successfully extended the original model with vendor-specific quality factors and found a significant effect. Therefore, the proposed model might be used as an alternative theoretical model for evaluating e-business success in future study. Second, this study applied AHP and found its appropriateness to resolve a complex website selection problem. AHP could be applied to future studies resolving various multi-criteria decision making problems in e-business areas. Finally, by investigating the relationship between website preference and business performance, this study opens the door for further studies examining the relationship between a variety of e-business success factors and business performance measures.

From a practitioners' perspective, the findings of a perceptual gap provides managers/designers an insight that they have to carefully reexamine customers' needs and preferences when they develop or update their websites. Using proposed system design methods resolving the perceptual gap problem between customers and designers is recommended [60]. In addition, the proposed model can be used for guiding managers/designers in measuring the quality level of their websites. At the same time, the model can be used to compare the quality level of a company's website with that of competitors. By gauging website quality levels and comparing with competitors' websites, e-business companies can make strategic and resource allocation decisions on how to improve current websites for e-business success. Finally, the research model, criteria and their relative impact provide useful information for the decision makers of e-business companies to develop decision support systems to monitor the performance of the current websites and provide strategic suggestions to develop enhanced websites.

In conclusion, evaluating e-business success is a challenging issue, but should be undertaken to examine payoffs of investment in e-business systems.

Appendix A. Online purchasing scenario

Let us assume that you are a customer who wants to buy a new [cellular phone] at [Amazon.com]. Please follow the scenario and complete the whole purchasing process.

1. Go to [Amazon.com] and take a look at the homepage for 3 min. You can read the content, and navigate the website using menus or hyperlinks. Please make sure you are familiar with the structure, features, and design of [Amazon.com] website.
2. Find the web pages of [cellular phones] by either using a search engine or clicking the hyperlinks.
3. Take 5 min to select your target [cellular phone]. You may compare features, images, service plans, service providers, and rebate information of the candidate [cellular phones].
4. Go to the target [cellular phone] web page, click customer images, read the product description, special promotion, and customer reviews in detail.
5. Click Help to see customer support information.
6. Proceed to Checkout. Enter all information that you need to complete the checkout process. It would be fine to provide address, credit card info, shipping method until you encounter the 'Place Order' screen.
7. Read 'Privacy Notice', 'Return Policy' and 'Conditions of Use'.
8. Spend 2 or 3 minutes to check whether features (e.g., content, structure, color, buttons, hyperlinks, etc.) of this website are easy-to-learn, consistent, concise, and readable.

Appendix B. Survey

Criteria	Definition	Sample items
Relevance	Relevant depth and scope, and completeness of the information	Richness of information, content relevant to the core audience
Currency	Updating of the information	[online electronics] New release music CD/DVD image, information and consumer review, [online travel] flight arrival status information update
Understandability	Ease of understanding and clearness of the information	Clear in meaning, ease to comprehend, ease to read
Empathy	Caring and attention the online retailer provides its customers	Provide services with customer's best interests at heart, understand customer's specific needs
Reliability	Ability to perform the promised service dependably and accurately	Trustworthy, accurate, credible
Responsiveness	Willingness to help online customers and provide prompt service	Quality of FAQ feedback
Navigability	Website's capability to provide alternative interaction and navigating techniques	Ease to go back and forth, a few click to locate information
Response time	How quickly a system provides the results that a customer wants to find	[online electronics] Response time to get the search result screen after typing a product name and clicking submit button, [online travel] how long does it take to get the response screen after providing all airline ticket information
Personalization	Individualized interface, effective one-to-one information, and customized service	Individualized interface, effective one-to-one information, and customized service
Telepresence	Sense of presence in the websites	Personal ties to the website, emotionally connected to the website, taking part with the website
Security	Quality or state of being secure	Presence and strengths of encryption systems, third-party affiliations, security and privacy policy
Awareness	Existence of a critical mass who knows and experiences the website	Average # of visitors (alexa.com)
Reputation	Overall quality as seen or judged by online consumers	Website reputation anking (e.g., seoexpert.com)
Price savings	Lower the cost of online purchasing	Average price of the same products (cellular phone, notebook, book, cd, dvd title)

Appendix C. Survey instrument

This appendix includes a condensed version of the survey instrument. Due to its considerable length, the entire survey is not included.

1. Which website do you prefer based on information relevancy?
2. Which website do you prefer based on information currency?
3. Which website do you prefer based on information understandability?

4. Which website do you prefer based on empathy?
5. Which website do you prefer based on reliability?
6. Which website do you prefer based on responsiveness?
7. Which website do you prefer based on navigability?
8. Which website do you prefer based on response time?
9. Which website do you prefer based on personalization?
10. Which website do you prefer based on telepresence?
11. Which website do you prefer based on security?
12. Which website do you prefer based on awareness?
13. Which website do you prefer based on reputation?
14. Which website do you prefer based on price savings?
15. Compare the relative importance of relevance, currency, and understandability with respect to information quality.
16. Compare the relative importance of empathy, reliability, and responsiveness with respect to service quality.
17. Compare the relative importance of navigability, response time, personalization, telepresence, and security with respect to systems quality.
18. Compare the relative importance of awareness, reputation, and price savings with respect to vendor-specific quality.
19. Compare the relative importance of information quality, service quality, systems quality, and vendor-specific quality in choosing the most preferred website. Alt1 site____ Alt2 site____ Alt3 site____ Alt4 site_____.

For survey questions 1 through 19 listed above, we included the following table. The table includes the 9-point scale for all possible pairwise comparisons associated with each specific question and serve as a convenient response mechanism.

	1=equal	3=moderate	5=strong	7=very strong	9=extreme					
Alt1	1	2	3	4	5	6	7	8	9	Alt2
Alt1	1	2	3	4	5	6	7	8	9	Alt3
Alt1	1	2	3	4	5	6	7	8	9	Alt4
Alt2	1	2	3	4	5	6	7	8	9	Alt3
Alt2	1	2	3	4	5	6	7	8	9	Alt4
Alt3	1	2	3	4	5	6	7	8	9	Alt4

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