Website Efficiency, Customer Satisfaction and Customer Loyalty:

A Customer Value Driven Perspective

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Abstract

This paper proposes a customer value driven perspective for analyzing the design of Internet retailing websites, the initial stage in the electronic service delivery channel. As a loyal customer base is crucial for website profitability over both the short and long term, customer satisfaction plays a critical role in determining both website efficiency and customer loyalty. The quandary facing Internet retailers is how to meet consumers' complex expectations for the retailing website without sacrificing speed and simplicity. The key to addressing this dilemma is to focus on customer value. This paper presents an empirical study of these issues using data from food retailing websites. The study uses Data Envelopment Analysis (DEA) and a post-DEA statistical analysis approach proposed in Xue and Harker (1999) to evaluate website efficiency and to analyze how website features affect website efficiency.

1. Introduction

E-retailing, "a giant industry" that "virtually awakens" (Fortune2000), has gone through rapid development and dramatic transitions in a relatively short period of time. Shopping has changed forever. While brick-and-mortar stores still hold the major portion of market share, Internet retailers have earned significant gains in recent years. A survey conducted by PricewaterhouseCoopers in January 2000 showed that nearly half of the primary shoppers in households with Internet access had made purchases on-line, up from 27 percent in 1998. In 1997, only 62 percent of these individuals visited websites more than three times per month. By the year 2000, the percentage climbed to 80 percent (Fortune 2000).

However, in stark contrast to the phenomenal performance of Internet companies in financial markets through the spring of 2000, many Internet retailers are now facing difficulties. Profit margins are still thin or absent, but investors now are demanding profitability. Many Internet companies' stock prices have fallen sharply. Venture capitalists are much more cautious and are reluctant to commit additional investments needed to keep numerous Internet companies alive.

This gloomy picture of present day e-commerce is not universal. For those who have focused from the beginning on customers rather than products or technology, significant growth opportunities still exist. The capability of developing loyal customers and the profitability that ensues from this loyalty holds great promise. To achieve this goal, flawless operations are crucial. In a market where a given product can be purchased from any number of retailers within a certain price range, what really makes the difference to the customer is how the product and associated service is delivered, not just the product itself. In other words, the key to survival and success for Internet retailers is to successfully deliver to the customer a service and associated website where the customer wants to frequently return to make purchases.

As customers return more frequently to the Internet to make purchases, the initial advantages of on-line shopping over brick-and-mortar stores turn into specific customer expectations. Potential advantages include round-the-clock operations, a wider range of product selection, lower prices, prompt delivery, and access to a customer service representative at any time. Recently, these expectations have become more complex. Websites are expected not only to have the traditional functions of retail stores, but also to offer a comprehensive package of content customized to fulfill a customer's personal needs and interests. These expectations have posed more than a technical challenge to Internet retailers. With limited resources, the design of the service delivery channel, starting from the front end (i.e., the website), requires a design methodology driven by an appropriate perspective -- a customer value driven perspective.

Why should we emphasize customer value in the design of the electronic service delivery channel? Customers' perceptions, or customers' satisfaction levels, of the quality of a service serve as the essential determinant of success (Zeithaml et al 1990, Heskett et al 1997). The Internet retailing market is characterized by aggressive competition and low switching costs. As a result, customer loyalty -- providing the so-called "stickiness" which is fundamentally based on a customer's satisfaction level -- is crucial. A loyal customer base -- the so-called "customer equity" of a firm -- is the cornerstone of the firm's prosperity in the long run. The ebb and flow of the dynamic retailing sector have made one thing clear: consumers, and only consumers, define value. A winning corporate strategy must focus on consumers. The corresponding operations strategy must focus on the customers as well to implement and support the corporate strategy. The design strategy of the service delivery channel is an essential part of this operations strategy.

In this paper, we adopt a customer value driven perspective to guide an analysis of the resource allocation decision-making process for Internet retailing website design, the very beginning of the

"service supply chain" of an e-retailer. A Data Envelopment Analysis (DEA) model that includes customers' perception of the service quality delivered through the website as an output is used to measure website efficiency. Website design is the crucial initial step that determines the key features of a website, which in turn influences the quality of service delivered through the website. In practice, many retailing websites are designed according to common sense or common practice, with little thought given to quality as defined by the customer. Thus, it is important to explore the potential relationship between website features and customers' perception of the quality of the service delivered through the website. When resources are limited, this decision about which features the website should carry to satisfy customers' multiple needs is crucial. A second stage analysis investigates the effect of a wide range of website features on website efficiency by using an approach proposed in Xue and Harker (1999).

The rest of the paper is organized as follows. In Section 2, we will review the related literature. In Section 3, the proposed customer value driven perspective for retailing website design is introduced. An empirical study of a sample of food retailing websites is described and discussed at length in Section 4. In Section 5, the insights gained through this study are summarized and the directions for future research are also discussed.

2. Literature Review

There are two main streams of the literature that our work is related to: the design of electronic services and the study of service quality using Data Envelopment Analysis (DEA).

The design stage of an electronic service determines the key features of a service, the ease of maintaining and improving a service, and the service quality delivered through this channel. Yet, in practice, many retailing websites have been designed according to common sense or common practice (Conallen 2000), with little thought given to quality as defined by the customer. Practitioner methodologies for web application design and service design are available (Conallen 2000; Dubé et al. 1999), yet informal and sometimes even contradictory suggestions remain the common means of describing appropriate electronic service design (Greenspun 1999; Hanson 1999; Nielsen 2000; Siegel 1996). The academic literature also has approached the electronic service design problem, but primarily with the objective of building a typology (Hoffman et al 1995**;** Hanson 1999; Heim and Sinha 2000) or an empirical taxonomy (Spiller and Lohse 1998; Heim and Sinha 1999a,b). A few studies have considered the implications of such models. For example, Heim (2000) studied the relationship between service quality and taxonomies constructed from attributes of electronic retailers.

Data Envelopment Analysis (DEA) techniques are increasingly being employed to analyze the performance and the quality of service operations. The managerial goals of a DEA analysis include identification and classification, performance evaluation, and resource allocation (Metters et al 1999). Thanassoulis et al. (1995) included service quality as an output in their DEA model used in a health care setting. Soteriou and Zenios (1999) developed and analyzed a conceptual model of service quality efficiency in banking services based on the Heskett et al (1997) service profit chain. DEA studies of service quality have employed both single-stage and two-stage empirical methods. The single-stage methodology allows researchers and managers to identify

which services are efficient in their transformation of inputs into service outputs such as service quality. Soteriou and Stavrinides (1997) employed a single-stage approach to analyze the service quality of bank branches. Two-stage methods can help to explain or to improve upon first-stage empirical analyses, to potentially provide insights about why services are efficient. For example, Athanassopoulos (1997) used a latent variable regression approach to analyze the relationship between the perceived quality of service processes and DEA efficiency scores for bank branches.

Several recommendations have been made about how to use efficiency scores in post-DEA analysis (Metters et al 1999). A serious flaw of the two-stage approach generally followed in the literature, the ignorance to the inherent dependency of DEA efficiency scores, was first pointed out in Xue and Harker (1999); the authors proposed a Bootstrap approach to solve this problem. According to Xue and Harker (1999), the ignorance of the inherent dependence of DEA scores in hypothesis testing can cause invalid and misleading results. Another issue related to using DEA to measure the efficiency of services is how to represent customer perceptions of service quality in the DEA model (Cook et al 1993, 1996). Recent work related to this issue can be found in Cooper et al (1999).

3. A Customer Value Driven Perspective for Retailing Website Design: Linking Website Design, Customer Satisfaction and Customer Loyalty

To the best of our knowledge, none of the previous work in the literature aimed at providing either a typology or a taxonomy for retailing website design has ever taken a customer value driven perspective. In terms of this perspective, we mean that the design of the website should aim at customer satisfaction as the essential goal of the design. When regarding a website as a production unit similar to a traditional storefront, customer satisfaction is one of the essential outputs in addition to the tangible outputs, such as sales. Customer satisfaction levels depend on the service quality as perceived by the customer. As a result, in Zeithaml et al (1990), service quality is actually defined as "the discrepancy between customers' expectations and perceptions". They also show that customers do not evaluate service quality based solely on the outcome of the service, but also on the quality of the service delivery process. Therefore, the features of the service delivery channel ultimately influence a customer's satisfaction level.

While the features of a brick-and-mortar storefront influence the customers' shopping experience to some extent, the features of a website may influence customers' perceptions of their website shopping experience to an even greater extent. There are several reasons for this deeper influence of the website as compared with the traditional brick-and-mortar site. As we pointed out before, customers' expectations for on-line shopping are much more complex compared to what they have had for storefront shopping. In addition to conventional expectations such as a large selection of merchandise, access to customer service representatives, detailed product information and low prices, they also expect the website shopping experience to save them time and money while also being richer in content. A retailing website is the storefront for Internet retailers. It is the place where consumers see products, get product information, make purchases, choose a shipping method and possibly monitor their shipment, and handle any complaints and returns. However, consumers often expect it to be much more than just a storefront. They may expect a

channel to a community where they connect and associate with people who share similar lifestyles or common interests. Meanwhile, many on-line shoppers expect that their personal needs will be met with customized content.

Undoubtedly, it is challenging to attempt to meet such complex expectations through a single website. There exist both internal and external restrictions that inhibit fulfilling all of the customers' expectations. Inherently, there exists an upper limit for the features and functions one website can have. A retailing website is definitely expected to provide detailed, and ideally, vivid product information. However, while retailers are making efforts to fit everything they think consumers may want into one screen, consumers can become impatient with the resulting slow transfer speeds and overwhelmed by the amount of information they have to digest. The dilemma facing e-retailers is: when consumers are expecting one website to do many things, e-retailers have to decide which of the many to do, and to what extent they can be done without sacrificing the speed and simplicity of the website. Another restriction is always money. A more complex website requires many more resources to develop and maintain compared to a simpler website.

Numerous studies in the marketing literature have shown that there is a strong link between customer satisfaction levels and customer loyalty (Zeithaml et al 1990; Rust et al 1995; Anderson et al 1997; Fornell 2000). Consequently, we would expect that a more satisfied consumer is more likely to visit the website again compared to a less satisfied consumer. One distinguishing feature of Internet retailing is the intense competition over customers. Compared to traditional shoppers, on-line shoppers have surprisingly lower switching costs. In the past, Internet retailers have spent millions of dollars targeted at building brand name and acquiring customers, as an implementation of the "build customer base now and make profit later" strategy. This strategy was taken from the principle that a loyal customer base is a highly valuable, intangible asset owned by the firm, the firm's so-called "customer equity". Customer lifetime value has been

regarded as the firm's solid foundation for profitability in the long run. However, this strategy recently has been questioned and reevaluated, as the investment community's yearning for profitability has increased. The adjustment of the strategy means a shift of focus from pure brand-building and customer acquisition to customer retention. In order to deliver high quality services to the customer through the "service supply chain", a retailing website needs a design strategy focused on customer satisfaction and customer value.

4. An Empirical Study of the Food Retailing Websites

In this section, we investigate the case of food retailing websites. In Subsection 4.1, the industry background and the data set used in this study are introduced. In Subsection 4.2, in order to measure website efficiency, we construct a DEA model indicating the quality of the website performance as perceived by customers, which reflects customers' satisfaction level of their website shopping experience, as one output. In Subsection 4.3, the relationship among customer satisfaction, customer loyalty and website efficiency as measured by the DEA model is explored. Two groups of hypotheses which examine the influence of a wide range of retailing website features on website efficiency are tested in Subsection 4.4.

4.1 Background

Traditional food retailing, as a segment of the grocery industry, is a mature, extremely competitive and fragmented industry. The emergence of Internet shopping has created an opportunity for retailers to offer more types of shopping and more convenient shopping experiences. Our data were collected from a study sample of 255 Internet food retailers. At the time the sample frame for this study was collected (late 1998), this sample represented approximately one third of the food retailers that could be identified via search engines and interest sites. Out of the study sample of 255 websites, 46 were finally included in our study mainly because their customer satisfaction levels were reported by BizRate.com, one of the major Internet services dedicated to ranking electronic businesses based on actual customer reviews or expert reviews. The customer satisfaction and customer loyalty data employed in this study come from Bizrate.com's 1998 survey.

4.2 Website Efficiency

A DEA model is employed to measure website efficiency. Each retailing website in the sample is considered as an individual decision-making unit (DMU).

Electronic services consist of digital service content designed to replace the traditional front office service experience. The digital content presented in an electronic service essentially can be classified into two types: static content and dynamic content. Static content is simply downloaded to the customer, containing whatever information and graphics were designed for a page. In contrast, dynamic content is created by programs or scripting languages that can accept program arguments based on user requests made at the time the customer is consuming the electronic service. This balance between static content and dynamic content will serve different segments of customer needs. Static content typically fulfills needs that don't change over time or across customers. Dynamic content is often used to satisfy idiosyncratic or time-critical needs. Thus, when considering the efficiency and effectiveness of the use of digital content to satisfy customers, one might relate the performance measures of individual services to the measures of other services that employ similar static and dynamic contents. As a result, in the DEA model employed in this study, we measure the inputs of one website by the amount of dynamic and static contents of the website.

As in any service, there are two types of outputs of a retailing website: tangible and intangible. The tangible outputs are those that can be directly counted, such as the number of goods offered, the number of visits and number of transactions completed at the website, and so on. Internet retailers usually cannot directly count intangible outputs. For example, consumers' satisfaction with their website shopping experience is usually not readily available to the Internet retailer. In the DEA model employed in this empirical study, we include both tangible outputs and intangible outputs. Even though such intangible outputs may not be able to fit directly in the balance sheet,

they surely contribute to the firm's profitability in both the short term and the long run. The reason for this satisfaction-profitability link lies in the fact that a satisfied customer is more likely to make frequent purchases on the website and recommend the website to her friends. Motivating repeated purchases and referrals turns customer satisfaction into profit. In the DEA model used in this empirical study, we include one tangible output, the number of goods offered at the website as a measure of the service scope, and one intangible output, the customer's satisfaction level of their website shopping experience, which is an aggregate measurement based on the evaluation of website performance along four dimensions: product information, website aesthetics, website navigation, and customer support. These four dimensions are among the most important ones that affect consumers' website shopping experience according to a survey conducted by PricewaterhouseCoopers (Fortune 2000).

The result of the DEA efficiency analysis shows that five of the 46 food retailing websites included in our study are on the efficiency frontier with their efficiency scores equal to one. Therefore, these five retailing websites are the most efficient in delivering satisfying service to their consumers among their peers in the observation set. Given the model orientation, the higher the DEA efficiency score, the lower the efficiency. The average DEA efficiency score is 5.02, which suggests that the most efficient websites are about five times as efficient as an average level food retailing website in the sample. The summary statistics for the DEA efficiency scores are shown in Table 1.

Table 1 Summary Statistics for The DEA Efficiency Scores

Minimum	Quartile 25%	Mean	Median	Quartile 75%	Maximum	Total Number	Standard Deviation
1.00	1.25	5.02	2.65	6.77	22.68	46	5.31

4.3 The Relationship of Website Efficiency, Customer Satisfaction and Customer Loyalty

The results of the correlation analysis shown in Table 2 suggest two things. First, there is a strong positive correlation between customer satisfaction of the website shopping experience and customer loyalty. The correlation coefficient is as high as 74%. Also, there is a significant positive correlation between website efficiency as measured by the DEA model and customer loyalty: the correlation coefficient is about 30%. These results support our idea of constructing a website focusing on a customer value perspective. A food retailing website that serves its visitors well can expect a bigger proportion of customers to return to make frequent purchases and to recommend it to others. Meanwhile, a website that is more efficient in using its resource to meet or even exceed its customers' expectations for their website shopping experience is more likely to have a loyal customer base.

Table 2 The Results of Correlation Analysis of Website Efficiency, Customer Satisfaction, and Customer Loyalty

Correlation Coefficient	Website Efficiency	Customer Satisfaction	Customer Loyalty
Website Efficiency			0.30
Customer Satisfaction			0.74
Customer Loyalty	0.30	0.74	

4.4 The Effect of Website Features on Website Efficiency

We now turn to the second stage of this study, with the aim of exploring the influence of certain website features on website efficiency. This analysis provides insight about the dilemma facing Internet retailers during the initial website design stage: How can one website meet consumers' complex expectations without sacrificing simplicity and speed under various constraints?

First, according to their different functions, we classified some of the major retailing website features into six categories as shown in Table 3.

Table 3 Retailing Website Features

Functional Category	**Website Features**
1.Website Navigation	1) Site uses image maps 2) Site search system 3) Site sort system 4) Site includes a site map
2.Shopping Tool	5) Shopping cart 6) Cost calculator
3. Order Fulfillment	7) Shipment tracking system integrated into the website 8) Product in-stock level listed on the website
4. Customer Support	9) Nutritional information posted on the website 10) Decision tool or expert system included 11) Direct link between recipes and the order system 12) Customer service representative phone number posted
5. Community	13) Membership program 14) Customer registration procedure required 15) Customer information collected 16) Customers are invited to post on the website
7. Customization and Variations	17) Number of shipping options 18) Number of payment options 19) Offer shipment of the product as a gift 20) Offering product/service customization

Category 1: Website Navigation Website Features

A consumer sometimes can be overwhelmed by the amount of information available on the Internet. The possibility of quickly finding exactly what he or she wants on the website is therefore very important. Research shows that more than 95 percent of website visitors who are potential customers leave a website without buying anything mainly because they just cannot find what they want (Fortune 2000). Therefore, a popular retailing website is expected to be equipped with an efficient and user-friendly search system, which is critical to increase sales, profits and overall customer satisfaction. A sort system is also necessary to give the consumer the flexibility to customize the product catalog according to his or her own preference. This group of website attributes includes site search systems (e.g. search by term), site sort systems (e.g. sort by price, name etc.), site maps, and image maps.

Category 2: Shopping Tool Website Features

A shopping cart system, which is often linked to the cost calculation system and a customer information database, has become a standard tool available at many retailing websites. Shopping carts create a win-win scenario because they not only save the consumer's time but also increase the "stickiness" of the website. The fact that consumers can avoid typing the required customer information again can be an incentive for a consumer to stay with a "familiar" Internet retailer who "knows" him or her personally. This group of website features may include a shopping cart system and on-the-fly calculation of total order costs (i.e., shipping costs are integrated into the shopping cart system to present the customer with a grand total for their purchase).

Category 3: Order Fulfillment Information Facilitating Website Features

Customers often get upset and sometime even feel cheated when the product they ordered does not arrive at their doorstep when they expected it to arrive. Such incidents are

destructive for building the trust relationship between the retailer and the customer. It is commonly acknowledged that poor order fulfillment is one of the major factors that turn consumers away from e-retailers, especially during peak retailing seasons. Research shows that 20 percent of consumers rank "delivery within a specific time frame" and 21 percent of consumers rank "shopping site is operated by a retailer or store I trust" as one of the top three factors for them to purchase from a specific Internet retailer (Fortune 2000). Although order fulfillment is the direct outcome of the back-office operations, a website can facilitate information sharing and information flow among the customer, retailer, distributor and supplier as well as help to set and/or adjust customers' expectations. Such website features include shipment tracking integrated into the website, listing product in-stock inventory levels on the website, and offering back-in-stock notification services at the website. Making inventory information transparent and allowing a customer to keep track of the location of her purchased item can help to adjust the customer's expectations and to smooth the information flow.

Category 4: Customer Support Website Features

Some retailing websites are making efforts to improve their customer support by providing detailed product related information at the website, for example, nutritional information pages and decision tools or expert systems such as a recipe calculator. In some food retailing websites, recipes are directly linked to the order system. Consumers are also invited to post their recipes on the website. Many retailing websites list their customer service representative toll free phone number on the websites for the customers to call in case they need individual help during their shopping process. These features are designed to better provide support to the customer.

Category 5: Community Building Website Features

A membership club has become a common feature of many retailing websites along with a customer registration procedure. As a matter of fact, customer information collected by the e-retailers is regarded as a highly valuable asset for future marketing and sales efforts. As we mentioned before, a consumer may intend to go to a "familiar" and trusted Internet retailer who "knows" him or her personally so as to avoid repeatedly typing required customer registration information, shipping addresses and credit card information. Other features designed to build a consumer community to increase customer "stickiness" include message boards and chat facilities on the website. These website features fulfill customers' personal needs and interest for communication and association with others who share common interests or a similar lifestyle.

Category 6: Product and Service Variation and Customization Website Features

In modern society, individual identification and needs are emphasized, and product and service variation and customization are often desired. Compared to traditional retailers, e-retailers often have more ability to vary and customize their offerings. There are several reasons for this ability. First, they know their customers "personally" with the help of their massive customer information databases. Second, using technology, they can let the customers specify their requests and preferences through interactions on the website. The third reason for this ability is that a big portion of their service offering is informational content, which is easier to customize than physical products. Some of the website features fitting into this category include offering product or service customization and a variety of shipping and payment options. Some retailing websites also offer to ship the purchased products as a gift to a third party.

In this study, we are both interested in the individual website feature's influence on website efficiency and the overall influence of each functional category of website features as listed in Table 3. In other words, we are interested in testing the following two types of hypotheses:

H1: "A certain individual website feature (for example, "site search") influences website efficiency significantly."

H2: "The overall influence of a certain functional category of website features (for example, "website navigation" category) on website efficiency is significant."

Consequently, we performed a two-phase study. In the first phase, we investigate individual website feature's influence on website efficiency one by one for each of the 20 website features listed in Table 3. Then we shift the focus to the overall influence of the functional category by conducting the principle component regression analysis one by one on the six categories listed in Table 3.

Before we move on to the discussion of our results, we want to point out several things regarding our methodology. First, we use the Tobit regression model. The reason for using a Tobit regression model is to eliminate the ceiling effect of the DEA efficiency scores (i.e., the efficiency scores generated by the output-oriented DEA model are bounded by one from below). Second, we apply the Bootstrapping approach for hypothesis testing proposed in Xue and Harker (1999) with 200 Bootstrap replications in order to deal with the inherent dependency problem of DEA efficiency scores. Third, the correlation analysis results (see Appendix A) show that the correlations among the website features within each category are not strong enough to cause any serious problems for the statistical estimations and inferences we have in this paper.

Phase 1: Individual Website Feature Effect on Website Efficiency

In this phase, we test the first set of hypotheses by fitting the Tobit regression model shown below for each individual website feature, following a hypothesis testing procedure proposed in Xue and Harker (1999):

$$q_i = a_j + b_j x_{ij} + e_{ij} \qquad (1) \qquad \text{for } j = 1,2,...,20$$

Here q_i is the DEA efficiency score of the ith website (i = 1, 2, …, 46). x_{ij} is the dummy variable indicating the availability of the jth (j = 1, 2 , …20) website feature on the ith website. b_j is the corresponding regression coefficient. For the jth (j = 1,2, …20) website feature, the null hypothesis to be tested with a t-test and the corresponding two-sided alternative hypothesis are:

$H_{10}^{j} : b_j = 0$ vs. $H_{11}^{j} : b_j \neq 0$ for j =1,2,…, 20.

The complete results for the hypothesis testing of all of the 20 individual website features are included in Appendix B. According to the t-test, one website feature, the "number of payment options", significantly influences a food retailing website's efficiency. According to the results of 200 Bootstrap replications, the p-value of the t-test for the "number of payment options" is 0.0293, which is less than 0.05, the significance threshold for hypothesis testing. Therefore the corresponding null hypotheses is rejected and we conclude that the website feature, "payment options", has a significant influence on website efficiency.

The results suggest that customers feel more comfortable when they have more choices of payment means. That is, consumers evaluate the flexibility and convenience of payment means very highly. Basically, more payment options provide on-line shoppers more flexibility to address their various concerns involving privacy, security and convenience. While many customers are ready to submit their credit card number and other personal

information through the Internet, some are still reluctant to do that and would prefer to call a live sales assistant to give that information or even to mail a paycheck. A website able to offer more payment options is more likely to efficiently use its website resources to satisfy its customers with diverse preferences.

Phase 2: The Overall Effect of Each Functional Category of Website Features

Now we shift our focus from individual website feature's effect to the overall effect of each functional category. Consequently, we apply a principal component regression method along with the Bootstrapping approach proposed in Xue and Harker (1999) to test a series of the second type of hypotheses.

First, we apply principal component analysis to each category of website features as listed in Table 3. The results of the principal component analysis are included in Appendix C. We pick the first principal component for each category for the regression analysis. We fit the following Tobit regression model for each of the six principal components with 200 Bootstrap replications:

$$q_i = p_k + l_k Z_{ik} + d_{ik} \qquad (2) \qquad \text{for } k = 1,2,...,6.$$

Here q_i is the DEA efficiency score of the i th website (i = 1, 2, …, 46). Z_{ik} is the value of the i th website's first principal component corresponding to the k th functional category of website features (k =1,2,…,6). l_k is the corresponding regression coefficient. For the first principal component corresponding to the k th functional category of website features listed in Table 3, we test the null hypothesis with the two-sided alternative hypothesis as below:

$H_{20}^{k} : l_k = 0$ vs. $H_{21}^{k} : l_k \neq 0$ for k =1,2, …,6

The complete results for all of the six principal components can be found in Appendix D. The results show that that both Z_1, the first principal component of category 1 ("website navigation" functional website features including "image map", "site search", "site sort" and "site map"), and Z_4, the first principal component of category 4 ("customer support" functional website features including "nutritional information page", "decision tool or expert system on site", "direct link between recipe and order" and "customer service representative phone number posted"), have significant influence on website efficiency. With 200 Bootstrap replications, the p-value of the t-test for Z_1 is 0.023, which is less than 0.05, the significance threshold. Hence the null hypothesis H_{20}^1 is rejected at the 0.05 significance level. Thus, we can conclude that the overall influence of the website features included in the "website navigation" functional category on website efficiency is significant. Similarly, since the p-value of the t-test for Z_4 is only 0.0028, we also conclude that the overall influence of the website features included in the "customer support" functional category on website efficiency is significant.

As we indicated before, surveys report that more than 95 percent of a website's visitors who were potential customers left the website without making any purchase due to not being able to find exactly what they wanted on the website (Fortune 2000). This figure suggests how important a user-friendly and efficient website navigation system is to satisfy customers. The result of the hypothesis testing of Z_1 is consistent with this suggestion. We notice that in the study of individual website feature's influence on website efficiency in Phase 1, none of the four website features in the category ("image map", "site search", "site sort" and "site map") are shown as significant factors. However, the study of the overall influence of the whole category shows that even though individually none of the four website features have significant influence on website efficiency, as a whole, the overall influence of this functional category on website

efficiency is significant. This suggests that the interactions among the four website features in this category may actually contribute to the variations of website efficiency.

The "customer support" functional category is also recognized as having an overall significant influence on website efficiency. The availability of three of the website features included in this category, "nutritional information page", "dynamic decision tool/expert system" and the "automatic direct link between order and recipe", could have delighted the customers simply because these website features exceeded their expectations in late 1998 when on-line shopping was still relatively new and not well-developed. This speculation is based on the finding in marketing research that suggests that customer satisfaction can result from the mere fascination with the capabilities of new technology-based service such as Internet shopping (Meuter et al 2000). In such cases, just having the website do what it is intended to do is enough to satisfy many customers. The novelty of Internet shopping itself was a source of satisfaction at that particular stage ---when it was still new. Besides, according to the major customer satisfaction theory in marketing, customer satisfaction is a function both of expectations and perceptions (Swan and Combs 1976, Lilien et al 1992). Consequently, if the quality of service meets his expectations, a consumer is satisfied; and if it actually exceeds his expectations, he or she will be highly satisfied or delighted. Thus, when the website provides more than just what the customer had expected (to complete a purchase transaction smoothly) by providing additional customer support, such as nutritional information and recipes, customers were pleasantly surprised and delighted.

As for posting customer service representative phone numbers on the website, it contributes to customer satisfaction in two ways. On one hand, according to consumer psychology and behavior theory, in the process of adopting a new self-service technology, the idea of losing human contact and aid often frightens some consumers who are less comfortable with machines.

On the other hand, the access to a live customer representative is a necessary supplement to the interactive self-service shopping environment on a website as many complicated cases can only be well handled by human beings rather than by the computer. Thus, the listing of a live customer representative's phone number on the website is often appreciated by the customer. Again, even though none of the website features included in this category individually were recognized as having significant influence on website efficiency, the whole category has a significant overall influence on website efficiency.

In summary, the study of each functional category's influence on website efficiency supplements the first stage investigation of individual website feature's influence on website efficiency as it considers the possible influence on website efficiency's variations due to the interactions of website features within the same category.

5. Summary

Website efficiency has been studied before, but mainly from the point of view of the technology used in their design and operations. In this paper, we emphasize that an Internet retailer should take a customer value driven perspective while making any decision concerning the design of the electronic service delivery channel, rather than being product-driven or technology-driven. That is, the dilemma facing Internet retailers, "how to meet consumers' complex expectations for the retailing website without sacrificing speed and simplicity", should be solved by adopting a website design strategy focusing on customer value. By so doing, the Internet retailer can expect a loyal customer base for short term and long run prosperity.

The results of our empirical study of food retailers on the Internet supports our idea of a customer value driven website design strategy. The analysis shows there exists a strong relationship between customer satisfaction and customer loyalty as well as between website efficiency and customer loyalty. Further analysis of individual website features and their functional categories' influence on website efficiency created insights into the dilemma and suggested the direction of a possible solution. The investigation of individual website features' influence on website efficiency recognize "payment options" as a significant factor. A second phase study of the overall influence of the functional categories of website features supplemented the picture by considering the effect on website efficiency resulting from the interactions of website features within the same functional category. The results of this phase show that both the "website navigation" functional category and the "customer support" functional category have significant overall influence on website efficiency.

By taking a close look at the results, we gained several insights about how to solve the dilemma we pointed out before:

1. A retailing website, one type of self-service technological tool, can be used to its full advantage only when the website is designed by focusing on the customer, simply because on-line shopping is a co-production process in which the customer takes the active leading role.
2. The customer's satisfaction of his or her website shopping experience, which links website performance to e-retailer's prosperity by building customer loyalty, is the function of the customer's expectations and perceptions of the quality of service delivered through the website.
3. It is a mistake for the e-retailer to attempt to fit everything into one screen or build a complicated website ---- consumers cherish simplicity and efficiency. Since the first thing for a consumer wandering into a website is to quickly find what he or she wants, a user-friendly and speedy website navigation system is crucial. Otherwise, the consumer will instantly leave without giving the e-retailer a second chance.
4. To be considerate and thoughtful to your customers is rewarding. For example, when she buys a salmon steak from you, recommend a recipe. Or when she is struggling with the computer or she needs some consulting to address her specific preference or concerns about the product, a live customer service representative's phone number flashing on the screen is regarded as thoughtful. Such little things help to build the trust and friendly relationship between the customer and the retailer while most on-line shoppers stick to the retailers they regard as "trustworthy" (Fortune 2000). A pleasant little surprise delights the customer greatly and boosts his or her satisfaction to a high level, and then wins his or her loyalty at the end.
5. Flexibility of payment means is also important. Consumers often have various concerns about the means of payment of on-line shopping such as privacy, security and convenience. While more and more consumers are comfortable about submitting their credit card numbers and other personal information through Internet, some may still

prefer to call a customer representative to give these information or even mail a personal check. Therefore, to offer more options is one way to prevent the potential customers from dropping out at the last minute.

The strategic design of retailing website is an open topic that needs further attention. The customer value driven perspective we proposed in this paper is one such effort aimed at improving our understanding about this topic and approaching the solution to the dilemma facing the e-retailers. The conclusions and insights gained from our empirical study may be limited due to the sample size. For all these reasons, future research in this area needs to be pursued.

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Appendices

(Note: In Appendix A, B, C and D, V1~V20 represent the 20 website features listed in Table 3 sequentially. Z1~Z6 represent the first principal components of the six functional categories listed in Table 3 correspondingly.)

Appendix A: The Results of Correlation Analyses of the Website Features

Table A1 Website Navigation Functional Category

	V1	V2	V3	V4
V1	1.0000	0.0288	-0.1410	0.1144
V2	0.0288	1.0000	0.0093	0.3213
V3	-0.1410	0.0093	1.0000	0.2065
V4	0.1144	0.3213	0.2065	1.0000

Table A2 Shopping Tool Functional Category

	V5	V6
V5	1.0000	0.4943
V6	0.4943	1.0000

Table A3 Order Fulfillment Information Functional Category

	V7	V8
V7	1.0000	-0.0922
V8	-0.0922	1.0000

Table A4 Customer Support Functional Category

	V9	V10	V11	V12
V9	1.0000	0.0240	0.1111	0.1777
V10	0.0240	1.0000	-0.0922	0.1353
V11	0.1111	-0.0922	1.0000	0.1023
V12	0.1777	0.1353	0.1023	1.0000

Table A5 Community Building Functional Category

	V13	V14	V15	V16
V13	1.0000	0.1973	0.0181	0.0577
V14	0.1973	1.0000	0.2497	0.0332
V15	0.0181	0.2497	1.0000	0.1931
V16	0.0577	0.0332	0.1931	1.0000

Table A6 Variations/Customization Functional Category

	V17	V18	V19	V20
V17	1.0000	0.0206	0.0583	0.1497
V18	0.0206	1.0000	0.0155	0.2882
V19	0.0583	0.0155	1.0000	-0.2316
V20	0.1497	0.2882	-0.2316	1.0000

Appendix B The Analysis of Individual Website Features' Effect

Table B1 The Hypotheses Testing Results of Individual Website Features

Website Features	**p-value**	**Null Hypothesis** $H_{10}^{j}: b_j = 0$ **, (j =1,…,20)**
V1	0.6152	Tenable
V2	0.4526	Tenable
V3	0.4249	Tenable
V4	0.4236	Tenable
V5	0.9891	Tenable
V6	0.7141	Tenable
V7	0.7056	Tenable
V8	0.4348	Tenable
V9	0.9494	Tenable
V10	0.4868	Tenable
V11	0.9613	Tenable
V12	0.5386	Tenable
V13	0.5255	Tenable
V14	0.432	Tenable
V15	0.3551	Tenable
V16	0.6386	Tenable
V17	0.4428	Tenable
V18	0.0293	***Rejected***
V19	0.9112	Tenable
V20	0.9236	Tenable

Appendix C Principal Component Analysis of Website Features

$$Z_1 = -0.2033 \times V_1 - 0.9011 \times V_2 - 0.0169 \times V_3 - 0.3826 \times V_4 \quad \text{(C1)}$$

$$Z_2 = 0.6537 \times V_5 + 0.7567 \times V_6 \quad \text{(C2)}$$

$$Z_3 = -0.9824 \times V_7 + 0.1869 \times V_8 \quad \text{(C3)}$$

$$Z_4 = 0.8508 \times V_9 + 0.1376 \times V_{10} + 0.1233 \times V_{11} + 0.4919 \times V_{12} \quad \text{(C4)}$$

$$Z_5 = 0.5033 \times V_{13} + 0.7163 \times V_{14} + 0.44 \times V_{15} + 0.2 \times V_{16} \quad \text{(C5)}$$

$$Z_6 = 0.9993 \times V_{17} + 0.0014 \times V_{18} + 0.0061 \times V_{19} + 0.0337 \times V_{20} \quad \text{(C6)}$$

Appendix D The Analysis of the Effect of the First Principal Component of the Functional Category

Table D1 The Hypotheses Testing Results

Principal Component	**p-value**	**Null Hypothesis** $H_{10}^{k}: l_k = 0$ **(k=1,…, 6)**
Z1	0.023	***Rejected***
Z2	0.9445	Tenable
Z3	0.9129	Tenable
Z4	0.0028	***Rejected***
Z5	0.8516	Tenable
Z6	0.3823	Tenable

Appendix E The Bootstrap Approach for Hypothesis Testing in Xue and Harker (1999)

Step 1: Construct the sample probability distribution $\hat{F}$ by assigning probability of 1/n at each DMU in the observed sample: ($x_1, x_2, ..., x_n$).

Step 2: Draw c (c is a constant) random samples of size n with replacement from the original sample ($x_1, x_2, ..., x_n$):

$$S_k = (x_{k1}, x_{k2}, ..., x_{kn}),\ k = 1, ..., c, \tag{E1}$$

where $x_{ki} = (u_{ki}, v_{ki}),\ i = 1, ..., n$. S_k is the so-called *Bootstrap sample*.

Step 3: For each Bootstrap sample S_k, $k = 1, ..., c$, run the DEA model or a variant of such models to recalculate the efficiency scores for all n DMUs:

$$q_{ki} = f_i(u_k),\ i = 1, ..., n, \tag{E2}$$

where f_i represents the DEA model or extended DEA model of choice for DMU i.

Step 4: For each Bootstrap sample S_k, $k = 1, ..., c$, evaluate the *Bootstrap replication* $\hat{b}_{kj}, k = 1, ..., c,\ j = 0, 1, ..., m$ by fitting the regression model of choice where the DEA efficiency scores are the dependent variables:

$$q_{ki} = G(b_k, v_{ki}) + e_{ki},\ i = 1,...,n\ , b_k = (b_{k0}, b_{k1},..., b_{kj},..., b_{km}); \quad \text{(E3)}$$

Note that any transformation of the DEA efficiency scores (e.g. the logarithmic transformation) can also be used as the dependent variables:

$$p(q_{ki}) = G(b_k, v_{ki}) + e_{ki},\ i = 1,...,n,\ b_k = (b_{k0}, b_{k1},..., b_{kj},..., b_{km}). \quad \text{(E4)}$$

Step 5: Estimate the standard error $se(\hat{b}_j)$ by the sample standard deviation of the c Bootstrap replications of $\hat{b}_j$:

$$\hat{se}_c(\hat{b}_j) = \left\{ \sum_{k=1}^{c} (\hat{b}_{kj} - \bar{b}_j)^2 \Big/ (c-1) \right\}^{\frac{1}{2}},\ j = 0,1,...,m, \quad \text{(E5)}$$

where

$$\bar{b}_j = \frac{\sum_{k=1}^{c} \hat{b}_{kj}}{c},\ j = 0,1,...,m. \quad \text{(E6)}$$

We call $\hat{se}_c(\hat{b}_j)$ the *Bootstrap estimator* for the standard error of $\hat{b}_j$.

Now, we are ready to use a t-test[1] to evaluate the following hypothesis:

$$H_0 : b_j = 0,\ vs.\ H_a : b_j \neq 0.$$

Calculate the test statistic according to:

$$t = \frac{\hat{b}_j}{\hat{se}_c(\hat{b}_j)}, \quad \text{(E7)}$$

and compare t to the critical value $t_{\alpha/2}$ from the student t distribution with (n-m-1) degrees of freedom. If $|t| > t_{0.025}$, reject the null hypothesis $H_0 : b_j = 0$ in favor of $H_a : b_j \neq 0$, at the $a = 0.05$ significant level. Otherwise, the null hypothesis $H_0 : b_j = 0$ is tenable at the $a = 0.05$ significant level.

[1] Notice that the Bootstrap method is a large sample method and, therefore, a Z-test can be substituted by t-test in practice.