



An empirical study on Web-based services and customer loyalty

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Abstract

E-business success is tied to the ability to foster customer loyalty. Businesses that deliver superior value derived from excellent services and quality products are likely to win customer loyalty. This paper examines Web-based services and the effects of three sets of factors: pre-purchase, transaction-related, and post-purchase services on customer loyalty (measured as repeat purchase intention from a given Web-based store) in a business-to-consumer environment. Based on the study's results, pre-purchase services that support search and evaluation of products replete in e-commerce systems have limited effect on customer loyalty. Among transaction-related services, transparency of the billing mechanism positively impacts customer loyalty. Customers shun any hidden costs associated with product acquisition. Post-purchase services consisting of support of order tracking, on-time delivery, and customer support positively influence customer loyalty. These findings imply that Web-based stores need to pay more attention to post-purchase services in their strategy to retain customers. This is what will keep customers satisfied and willing to continue the relationship with a company over the long term.

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Introduction

The Web serves as an intermediary between buyers and sellers for business-to-consumer (B2C) transactions in e-business. It creates an electronic marketplace that lowers the buyers' cost to acquire information about seller prices and product offerings (Bakos, 1997), and reinforces merchant–customer relationships through service delivery. Given its potential benefits, a number of organizations now use the Web for marketing, promoting, and transacting products and services with customers. E-commerce businesses are particularly concerned about keeping customers satisfied so that they keep coming back.

Winning consumer loyalty is a priority for e-businesses because it is a major driver for success in e-commerce (Reichheld & Scheffer, 2000). Over time, loyal customers are known to bring in substantial revenues and demand less time and attention from the firms they patronize. Consequently, customer loyalty can be a major source of sustained growth and profit for a company (Anderson & Mittal, 2000). Businesses that deliver superior value derived from excellent services and quality products are likely to win customer loyalty (Parasuraman & Grewal, 2000).

The study of Web-based service delivery is in its early stages. As a consequence, most of the research is concerned with mainly identifying and validating key Web-based service dimensions in an attempt to answer

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the question about what might induce customers to shop online or not. These studies are mainly exploratory in nature and often identify a detailed list of attributes through conceptual and qualitative analysis, which are then reduced to a few important dimensions through quantitative analytical approaches, such as factor analysis (e.g., Aladwani & Palvia, 2002; Ranganathan & Ganapathy, 2002). Although some dimensions are beginning to be researched more systematically (Zeithmal *et al.*, 2002), as yet, there is no unified view on the key dimensions. Specific Website design factors that influence customers' attitudes toward a Website include download delay, navigation (organization, arrangement, layout, and sequencing), content (amount and variety of product information), interactivity, responsiveness, value-added search mechanism, and perceived usefulness (e.g., Koufaris, 2002; Yang & Peterson, 2004). However, these studies do not test relationships between service dimensions and loyalty behaviors.

While some studies investigate the direct relationship between Web-based service dimensions and business financial outcomes (e.g., Saeed *et al.*, 2005) and the direct effect of customer loyalty behaviors on business financial outcomes (e.g., Reichheld & Scheffer 2000), they do not investigate the direct relationship between Web service dimensions and customer loyalty. There are some studies, however, that examine the relationship between Web design factors and customer loyalty. Wolfinbarger & Gilly (2003) found that Website design is the strongest predictor of customer loyalty intentions, while Thatcher & George (2004) found social involvement and Web esthetics to have an indirect effect on customer loyalty, mediated by commitment. There are some major limitations of these studies. First, they do not explicitly measure customer loyalty as the dependent variable nor do they inform us on Web-based service dimensions that can foster customer loyalty. The range of dimensions investigated in these studies have been quite narrow, ranging from an aggregate construct to a few dimensions. In a study where customer service ratings were found to influence loyalty, only pre-purchase assessment was done (Wolfinbarger & Gilly, 2003). Those results do not inform on the end of the purchase process and post-purchase factors that might influence a customer's likelihood to return to the same site (Ariely & Carmon, 2000). Second, some studies focus on shopping enjoyment. Social involvement and Web esthetics seem to be mainly associated with shopping enjoyment (Koufaris *et al.*, 2001, Thatcher & George, 2004). However, when shopping for products online, consumers are goal oriented, and perceived control of the shopping process is more important to them than shopping enjoyment (Novak *et al.*, 2000; Wolfinbarger & Gilly, 2001). Thus, these results have limited usefulness in forming our knowledge of Web-based service dimensions and loyalty behavior of online product shoppers, who are typically goal oriented. Third, the data used in most cases was not based on actual customer experience. It is useful

to gain insight into the antecedents to customer loyalty at the constituent dimensions level by using actual customer data, since this would help managers focus on significant Web-based service attributes that could improve their competitiveness.

Our study employs a comprehensive set of Web-based services and uses data based on actual customer online shopping experience collected by BizRate.com, in the context of purchases of computers. In doing so, empirical findings provide more relevant managerial implications based on the actual experience of customers.

Following Ives & Mason (1990), we adopt the concept of augmented service that involves providing the customer with additional support related to the acquisition and use of the product. Successful service augmentation targets the various activities that customers will be engaged in as they acquire and use the product. This view about services is particularly applicable to the product market where the service itself is not the end product. In a similar vein, Naumann (1995) states that for a firm to be customer driven, it must translate customer wants, needs, desires, and expectations into a product offering consisting of pre-sale services, transactions-related services, and post-sale services. Thus, service delivery through Websites pertains to the extent to which a Website facilitates efficient and effective shopping, purchasing, and delivery of products and services, and bears a comprehensive meaning encompassing pre-purchase, transaction-related, and post-purchase service aspects (Zeithaml *et al.*, 2002).

Anchored upon the concept of augmented service, we follow Naumann's (1995) pre-sale, transaction-related and post-sale service categorization to investigate the effects of Web-based service dimensions on customer loyalty as perceived by online consumers. We use repeat purchase intention – which refers to the likelihood of repeat purchase intention from the same product/service provider with affective commitment (Shemwell *et al.*, 1998) – as a measure of customer loyalty. Below, we present the constructs and the hypotheses of our research model, followed by a discussion of the research model, results, and implications of the study.

Research model

Most of the research concerning online consumer behavior is rather descriptive in nature and not based on consumer theory (Goldsmith, 2001). Further research is urgently required to explore the nature of the groups of factors that determine Internet shopping behavior (Elliot & Fowell, 2000). Our study is anchored upon the theory of reasoned action (TRA) (Fishbein & Ajzen, 1975; Ajzen & Fishbein, 1980). TRA is based on the proposition that an individual's behavior is determined by behavioral intention to perform that behavior (Fishbein & Ajzen, 1975). Behavioral intention is a function of one's salient belief that performing the behavior will lead to certain outcomes, which may be either favorable or unfavorable (Ajzen & Fishbein, 1980), based on personal evaluations

(attitudes) and on the approval of the people who are important to the individual (subjective norms). Potential predictor variables are assumed to influence intentions only to the extent that they affect either attitudes or subjective norms (Fishbein & Ajzen, 1975).

Below, we present a conceptualization of customer loyalty that is consistent with the TRA. This theory provides the linkage between attitudes and behavioral intent of online customers. We then present Web service dimensions identified from the literature, along with our research hypotheses.

Conceptualization of customer loyalty

In line with the thrust of TRA, the concept of customer loyalty often used in the extant literature incorporates behavioral and attitudinal measures simultaneously (see, e.g., Dick & Basu, 1994; Gremler & Brown, 1996). Dick & Basu (1994) emphasized that true sustainable loyalty could only be attained when customers enjoyed a high level of positive attitude toward the object, together with a high level of repeat patronage behavior. This concept is further emphasized by Gremler & Brown (1996), who state that loyalty is determined by the degree to which a customer exhibits repeat purchasing behavior from a provider and possesses a positive attitudinal disposition toward the provider. The above loyalty concept recognizes three conditions as suggested by Barnes (1994): (1) the customer should have strong desire for the product/service continuously or periodically; (2) the customer should have the freedom to choose a favorite product/service provider; and (3) there should be more than one product/service provider within a given industry.

Based on the attitudinal/behavioral conceptualization of loyalty, repeat purchase intention, repeat purchase behavior, and brand loyalty emerge as potential measures. While repeat purchase intention measures the likelihood of future purchases, repeat purchase behavior captures the already-existing continued commitment to an entity (Shemwell *et al.*, 1998). Brand loyalty is a favorable attitude toward a brand resulting in consistent purchase of the brand over time (Assael, 1992; Keller, 1993). Our study focuses on loyalty toward a specific store and employs repeat purchase intention as its measure of customer loyalty.

Dimensions of Web-based service construct

The common pre-purchase, transaction-related, and post-purchase Web-based service dimensions identified in the literature are presented in Table 1. We note upfront that we do not investigate security/privacy (protection of customers from the risk of fraud and financial loss/protection of personal information) and social involvement/interaction (a feeling of a sense of communality between the vendor and its customers) service dimensions in our model. There is some evidence in the literature showing that these dimensions are not very important to customers shopping for products online. Researchers have observed that security/privacy concerns were more important in the early days of e-commerce, but seem to be less important now due to the availability of secure modes of transmitting and safeguarding customer information, which are mostly standard across e-commerce Websites (Swaminathan *et al.*, 1999; Yang *et al.*, 2003). Also, online shoppers have been found to be

Table 1 Web-based service dimensions

<i>Service category</i>	<i>Common dimensions (from literature)</i>	<i>Reference literature</i>
Pre-purchase services	Support of product search and evaluation	Agarwal & Venkatesh, 2002; Aladwani & Palvia, 2002; Haubl & Trifts, 2000; Jahng <i>et al.</i> , 2002; Jarvenpaa & Todd, 1997; Keeney, 1999; Koufaris, 2002; Koufaris <i>et al.</i> , 2001; Liang & Lai, 2002; Palmer 2002; Ranganathan & Ganapathy, 2002; Torkzadeh & Dhillon, 2002; Tracy 1998; van der Heijden <i>et al.</i> , 2003; Wolfenbarger & Gilly, 2001; Zeithaml <i>et al.</i> , 2002.
	Web appearance /esthetics	Agarwal & Venkatesh, 2002; Koufaris, 2002; Koufaris <i>et al.</i> , 2001; Liu & Arnett, 2000; Thatcher & George, 2004.
	Product pricing	Bakos, 1997; Brynjolfsson & Smith, 2000; Burke, 2002; Keeney, 1999; Liang & Lai, 2002; Wan, 2000; Wolfenbarger & Gilly, 2001.
Transaction-related services	Delivery arrangements	Liang & Lai, 2002; Keeney, 1999; Reibstein, 2002; Rowley, 1996; Yang <i>et al.</i> , 2003; Zeithaml <i>et al.</i> , 2002.
	Security/privacy	Jarvenpaa & Todd, 1997; Keeney, 1999; Montoya-Weiss <i>et al.</i> , 2000; Novak <i>et al.</i> , 2000; Piccoli <i>et al.</i> , 2004; Reibstein, 2002; Torkzadeh & Dhillon, 2002; van der Heijden <i>et al.</i> , 2003; Wolfenbarger & Gilly, 2003; Yang <i>et al.</i> , 2003; Zeithaml <i>et al.</i> , 2002.
Post-purchase services	Billing and payment mechanism	Burke, 2002; Liang & Lai, 2002; Piccoli <i>et al.</i> , 2004; Torkzadeh & Dhillon, 2002.
	Order tracking	Burke, 2002; Koufaris, 2002; Liang & Lai, 2002; Lovelock, 1994; Piccoli <i>et al.</i> , 2004.
	Reliability/fulfillment	Keeney, 1999; Palmer <i>et al.</i> , 2000; Piccoli <i>et al.</i> , 2004; Wolfenbarger & Gilly, 2003; Zeithaml <i>et al.</i> , 2002.
	Customer support	Jarvenpaa & Todd, 1997; Keeney, 1999; Yang <i>et al.</i> , 2003; Zeithaml <i>et al.</i> , 2002.
	Social involvement/ interaction	Agarwal & Venkatesh, 2002; Keeney, 1999; Liang & Lai, 2002; Thatcher & George, 2004.

goal-oriented and desire to purchase what they want quickly and without distraction and social involvement (Novak *et al.*, 2000; Wolfinbarger & Gilly, 2001).

We also note that reliability/fulfillment is often treated as one dimension in the literature. However, this dimension incorporates both service-related and product-related attributes. Since our main focus is on service-related attributes, we breakup this dimension into two distinct dimensions: on-time delivery (service-related) and product satisfaction (product-related) in order to distinguish between service and product components. Furthermore, product pricing dimension is used as a control variable in our model since it pertains to price-induced loyalty. Our research model is presented in Figure 1 and our hypotheses development is described below.

Research hypotheses

Pre-purchase services

Support of product search and evaluation dimension includes Website mechanisms that enable customers to quickly search and evaluate products and features that make it substantially easier for them to locate information or content. It is a broad construct that includes site search features, information content, and ease of use/usability (see, e.g., Agarwal & Venkatesh, 2002; Aladwani & Palvia, 2002; van der Heijden *et al.*, 2003). Support of

product search and evaluation may be valued by customers because the combination of less time available for shopping, bounded cognitive abilities for information processing, and explosion of products and information available on the Web make them demand more control, less effort, and high efficiency during shopping (Jarvenpaa & Todd, 1997; Koufaris *et al.*, 2001). Therefore, support for product search and evaluation can contribute to minimizing a customer's cognitive effort and time spent searching and evaluating products before making a purchase decision, and is likely to enhance repeat visits to a Website that excels in providing this service (Jarvenpaa & Todd, 1997; Ansari *et al.*, 2000). Interestingly, Jahng *et al.* (2002) study relationships among online consumers' personality traits, product information presentation richness, and online consumer behavior in e-commerce environments. They find that effectiveness of product information presentation varies according to online consumers' psychological types: rich product information presentation significantly influences the online buying behavior of the intuitive and feeling types, rather than the sensing and thinking types.

Web appearance/esthetics dimension refers to the attractiveness or overall look and design of the Website and it is influenced by factors such as organization; proper use of fonts, colors, and multimedia; style consistency; and good labeling. Web appearance/esthetics induces feelings of positive affect in consumers, which may manifest as

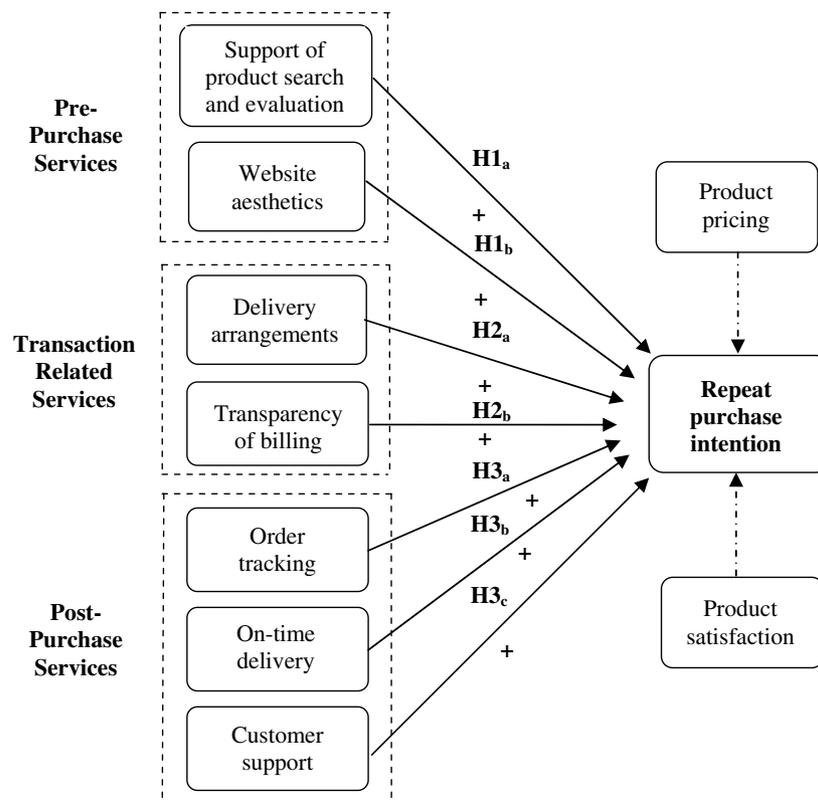


Figure 1 Research model.

playful or entertaining interaction with the Website, or shopping enjoyment (Liu & Arnett, 2000; Koufaris, 2002). In the retailing literature, it has been suggested that store environment contributes to consumers' shopping experiences (Baker *et al.*, 1994). Website design has been described as the virtual equivalent of retail atmospherics (Lohse & Spiller, 1998), and the graphic style and layout of a Website are close to the tangible dimension of service quality, the physical evidence of the service (Montoya-Weiss *et al.*, 2000). Thus, the role of Website esthetics (store atmospherics) in creating a compelling online experience is likely to be associated with customer loyalty (Haubl & Trifts, 2000; Lynch & Ariely, 2000).

Therefore, we hypothesize that:

H1a: *Customer evaluation of support of product search and evaluation is positively related to repeat purchase intention.*

H1b: *Customer evaluation of Website esthetics is positively related to repeat purchase intention.*

Transaction-related services

Delivery arrangements involve providing customers with several delivery options (e.g., UPS ground, priority next day, standard next day, 2- to 3-day delivery) to allow different speeds of delivery. Regardless of the delivery option chosen, customers value on-time delivery (Liang & Lai, 2002; Yang *et al.*, 2003).

Billing and payment mechanism is a supplementary service that combines the act of presenting a customer with the bill and collecting payment (Torkzadeh & Dhillon, 2002; Piccoli *et al.*, 2004). Customers seem to be more concerned about transparency of billing, based on anecdotal evidence (e.g., online shoppers were more likely to abandon a purchase during December 2003 due to hidden costs, such as shipping and handling – CIO Magazine, January 2004). Thus, a company that differentiates itself by providing outstanding delivery arrangements and transparent billing procedures is likely to stimulate customer loyalty. These observations lead to the following hypotheses:

H2a: *Customer evaluation of delivery arrangements provided by the Web-based store is positively related to repeat purchase intention.*

H2b: *Customer evaluation of the transparency of billing is positively related to repeat purchase intention.*

Post-purchase services

After purchase, customers are mainly concerned about justifying the purchase decision made by evaluating post-

purchase outcomes (Shafir *et al.*, 1993; Bettman *et al.*, 1998). Issues of concern to customers include the status of their order, when it is likely to be delivered, operation of the newly acquired product (after delivery), and how it fits into the portfolio of owned products. To alleviate these concerns, companies often provide order tracking services, attempt on-time delivery, and provide customer support.

Order tracking involves providing an online service where customers can track the status of their order (Liang & Lai, 2002; Piccoli *et al.*, 2004). Order tracking is particularly important to online shoppers given their unique circumstances. Typically, online stores cannot offer physical contact with products and preclude face-to-face interaction with a salesperson (Rowley, 1996). Customers are concerned with inherent risks, such as not knowing whether the product they have ordered has been dispatched and whether the right product has been shipped (Burke, 2002; Koufaris, 2002). Therefore, they may feel more comfortable if the status of their order is available.

Reliability/fulfillment consists of factors such as on-time and accurate delivery, accurate product representation, and other fulfillment issues (Piccoli *et al.*, 2004), and has been cited as one of the important dimensions of Web-based transactions (Zeithaml *et al.*, 2002). Since most companies are likely to deliver the actual product ordered, on-time delivery of customer order is the most critical aspect of reliability of service (Zeithaml *et al.*, 2002; Yang *et al.*, 2003).

Customer support involves providing customers assistance with the newly acquired product after product purchase. A key factor with customer support is responsiveness, which is a measure of the ability of the managers of the Web-based store to provide appropriate information for problem resolution, product returns or exchanges (if necessary), product integration into customer asset portfolio, and product maintenance (Liang & Lai, 2002; Zeithaml *et al.*, 2002). Customers also desire e-mail access to customer service and the ability to be able to speak to a live customer service agent online (Jarvenpaa & Todd, 1997; Yang *et al.*, 2003).

From the above discussion, we postulate the following set of hypotheses:

H3a: *Customer evaluation of Web-based store's order tracking feature is positively related to repeat purchase intention.*

H3b: *Customer evaluation of timely delivery of product by Web-based store is positively related to repeat purchase intention.*

H3c: *Customer evaluation of Web-based store's customer support services is positively related to repeat purchase intention.*

Control variables

Companies often rely on price differentiation, product differentiation, and service differentiation as competitive weapons (Zemke & Connellan, 2001). Price is a key attribute that most consumers consider in their purchase decision, and they are interested in finding the best price for a specific product (Keeney, 1999; Wolfenbarger & Gilly, 2001). The Web has lower search costs compared to conventional channels (Bakos, 1997; Brynjolfsson & Smith, 2000); thus, consumers are more likely to carry out extensive product price comparisons across online merchants in search of a better deal. While competitive pricing and product quality can lead to loyalty behaviors (Wolfenbarger & Gilly, 2001; GMA, 2002), our study measures customer loyalty that stems from customer service dimensions rather than from product pricing and product satisfaction. Therefore, product pricing and product satisfaction variables are included in the analysis to control for their possible effects on customer repeat purchase intention.

Research methods

To empirically test the hypotheses, this study uses a quantitative research approach based on the data gathered using individual-level instruments. Consistent with the TRA, these instruments assess human attitudes through direct questioning and are often used to help guide the design of information systems for effectiveness. However, rather than implement a new survey, we opted to use secondary data available through an established survey instrument. This offers several advantages. First, the data are collected from a broad section of companies, and this alleviates the limitation of using a sample of a few companies (e.g., Koufaris *et al.*, 2001). Second, the instrument used directly measures service delivery by online retailers based on actual customer purchase experience. Third, because the data are based on actual customer experience, empirical findings provide more relevant managerial implications than what would be the case for other methodologies (e.g., simulated lab experiments).

While several businesses have developed their own methodologies to measure service delivery by online retailers, BizRate.com's scale is the most reliable and is widely cited scale in popular literature (Zeithaml *et al.*, 2002). Therefore, we use BizRate's instrument and data for empirical analysis.

Data source

We derived data for empirical analysis from BizRate.com. BizRate's service dimensions (refer to Table 2) to a large extent correspond to the dimensions identified in the literature. For brevity, in our model we adopted names from extant literature for product pricing, Web esthetics, and delivery arrangements instead of BizRate's longer names. We adopted a modified name of 'transparency of billing' for BizRate's dimension called 'charges stated clearly before order submission' (called 'billing and payment mechanism' in the literature) because it is really the transparency of billing that the customers are concerned about (CIO Magazine, January 2004). Apart from 'support of product search and evaluation' dimension that combines two of BizRate's dimensions ('ease of finding what you are looking for' and 'clarity of product information'), all other dimensions used in our study are exactly BizRate's dimensions.

Sample selection

We collected secondary data from BizRate.com on a number of companies selling personal computers online. We restricted our sample to computers to ensure that all sampled companies exhibited similar characteristics. We took further precautions in sample selection. First, a given store had to be customer certified in order to be included in the sample ('Customer-certified' stores allow BizRate to gather reviews from their customers directly at the point-of-sale checkout and through follow-up e-mail surveys after fulfillment). Second, a given store had to have at least 100 reviews in order to be included in the sample (BizRate.com's threshold is at least 20 reviews). We arbitrarily chose a cutoff of 100 reviews (five times BizRate's threshold) to ensure that we use more reliable

Table 2 BizRate's dimensions and their measurement

<i>Dimension</i>	<i>When measured</i>	<i>Source of measurement</i>	<i>How measured</i>
<ul style="list-style-type: none"> • Ease of finding what you are looking for • Clarity of product information • Overall look and design of the site • Prices relative to other online merchants • Shipping charges • Variety of shipping options • Charges stated clearly before order submission 	At checkout	Stores that allow BizRate to collect feedback directly from their customers	Ten-point scale indicating a customer's evaluation of the different dimensions, ranging from poor on the lower-end to outstanding on the high-end
<ul style="list-style-type: none"> • Order tracking • On-time delivery • Product met expectations • Customer support • Would shop here again 	After delivery	BizRate.com's member shoppers	

data (the greater the number of reviews, the less a nonrepresentative customer's review influences the data). We ended with a usable sample size of 150 stores drawn from a total of 445 online stores selling computers listed in BizRate.com's company database.

BizRate's ratings gathering procedures

Table 2 highlights the measurement of BizRate's dimensions. A number of variables are measured at the point-of-sale or 'checkout'. Data are collected by asking a store's customers to evaluate their purchase experiences immediately after completing the online transaction. The remaining variables are measured post-purchase as an 'after delivery' follow-up. In addition to data gathered from customer-certified stores, BizRate also gathers reviews from its member shoppers who rate noncustomer-certified stores.

Customer store ratings for each dimension are based on a 10-point rating scale (from 1 = worst, to 10 = best). Appendix B presents a questionnaire used by BizRate to collect data from customers. Based on the two sources of data, the equation that determines each merchant's rating is calculated as follows for each dimension of service:

$$\frac{(Average\ Survey\ Scores \times Number\ of\ Surveys) + (Average\ Member\ Scores \times Number\ of\ Member\ Reviews)}{Number\ of\ Surveys + Number\ of\ Member\ Reviews}$$

Scores are computed weekly for stores that have at least 20 reviews in a 3-month period and are thus averages over time. Weekly recomputations address suspicious reviews or other unusual activity that undermines the reliability of prior ratings, and account for significant

changes to a store's Website or operations. This ensures data reliability and validity.

Statistical analytical methods

The following regression equation was estimated using least-squares procedures in order to test the hypotheses of the research model:

$$Y = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + \alpha_6 X_6 + \alpha_7 X_7 + \alpha_8 X_8 + \alpha_9 X_9 + \varepsilon$$

where: Y is the customer repeat purchase intention; X_1 the support of product search and evaluation; X_2 the Web store esthetics; X_3 the delivery arrangements; X_4 the transparency of billing; X_5 the support of order tracking; X_6 the on-time delivery; X_7 the customer support; X_8 the product pricing; X_9 the product satisfaction; and ε is an i.i.d error term with zero mean.

Results and discussion

Descriptive statistics

Summary descriptive statistics for rating scores are presented in Table 3. All ratings reflect averages ranging from 100 to over 50,000 reviews on a 1 (worst) to 10 (best) rating scale. All variables have mean rating scores of over 8 out of 10 and standard deviation of less than 1.00. Support of product search and evaluation has the highest mean rating score of 9.08, while customer support has the lowest mean rating score of 8.38. Minimum and maximum values and standard deviation coefficients imply that ranges in the ratings are reasonable, with no influential outliers.

Table 3 Summary descriptive statistics for service dimensions rating scores

Service dimensions	Attribute rating score			
	Mean	Standard deviation	Minimum	Maximum
<i>Pre-purchase dimensions</i>				
Support for product search and evaluation	9.08	0.28	8.4	10.0
Store esthetics	8.45	0.29	7.4	9.3
<i>Transaction-related dimensions</i>				
Delivery arrangements	8.48	0.47	6.7	10.0
Transparency of billing	8.48	0.35	7.6	10.0
<i>Post-purchase dimensions</i>				
Order tracking	8.67	0.55	5.5	9.7
On-time delivery	8.77	0.42	7.7	10.0
Customer support	8.38	0.61	6.6	9.7
<i>Control variables^a</i>				
Product pricing	8.90	0.30	8.0	9.8
Product satisfaction	9.03	0.32	8.4	9.8
<i>Customer outcome variable</i>				
Customer repeat purchase intention	8.71	0.42	7.7	9.6

^aNot service dimensions but used in the analysis as control variables. $N = 150$ stores; mean number of customer ratings/store = 32,451.

Results

We conducted preliminary analysis to assess the validity of using ordinary least-squares (OLS) procedure for empirical analysis to test the model. First, we checked if multicollinearity was a problem with the data set, which affects OLS parameter estimates and subsequent inference about variable significance. An examination of tolerance values, variance inflation factors, and condition number index (Belsley *et al.*, 1980; Neter *et al.*, 1990) suggested that multicollinearity was not a problem (please refer to multicollienarity test results in Appendix C).

Furthermore, we tested for heteroscedasticity, the presence of which makes OLS estimates inefficient and standard error estimates inconsistent, resulting in incorrect inferences. Tests for heteroscedasticity using both White's (1980) procedure and Goldfeld and Quandt's procedure indicated that this was a problem with the data set. Therefore, we implemented further analysis using OLS procedure by employing a heteroscedasticity-consistent covariance matrix (HCCM) developed by White (1980) and later modified by MacKinnon & White (1985) for small sample sizes (Appendix D outlines the concepts behind the HCCM). Figure 2 presents regression results derived using the heteroscedasticity-consistent estimator.

The estimated adjusted coefficient of determination (adjusted R^2) is 0.799 ($F = 66.894$, $P < 0.001$), indicating that the overall fit of the model is satisfactory. The results provide weak support for hypothesis H1a ($P < 0.1$), but not for hypothesis H1b ($P > 0.1$). These results suggest that customer evaluation of a given Web-based store's support of product search and evaluation features has a minimal positive influence on their repeat purchase intention ($\alpha_1 = 0.087$, $t = 1.858$), while their evaluation of Web esthetics does not influence repeat purchase intentions ($\alpha_2 = 0.073$, $t = 1.429$).

Customer evaluation of delivery arrangements provided by a Web-based store has no significant effect on their repeat purchase intention ($\alpha_3 = 0.017$, $t = 0.357$). Thus, hypothesis H2a is not supported ($P > 0.1$). The results provide support for hypothesis H2b ($P < 0.05$) about the transparency of billing ($\alpha_4 = 0.143$, $t = 2.139$). All the hypotheses pertaining to post-purchase services are supported (H3a and H3c at $P < 0.01$ and H3b at $P < 0.05$). Judging from the size of the estimated coefficients, customers are more concerned about the ability to track orders ($\alpha_5 = 0.227$, $t = 4.667$) than about on-time delivery ($\alpha_6 = 0.088$, $t = 2.002$). The most influential determinant of customer loyalty is customer support ($\alpha_7 = 0.565$, $t = 9.906$).

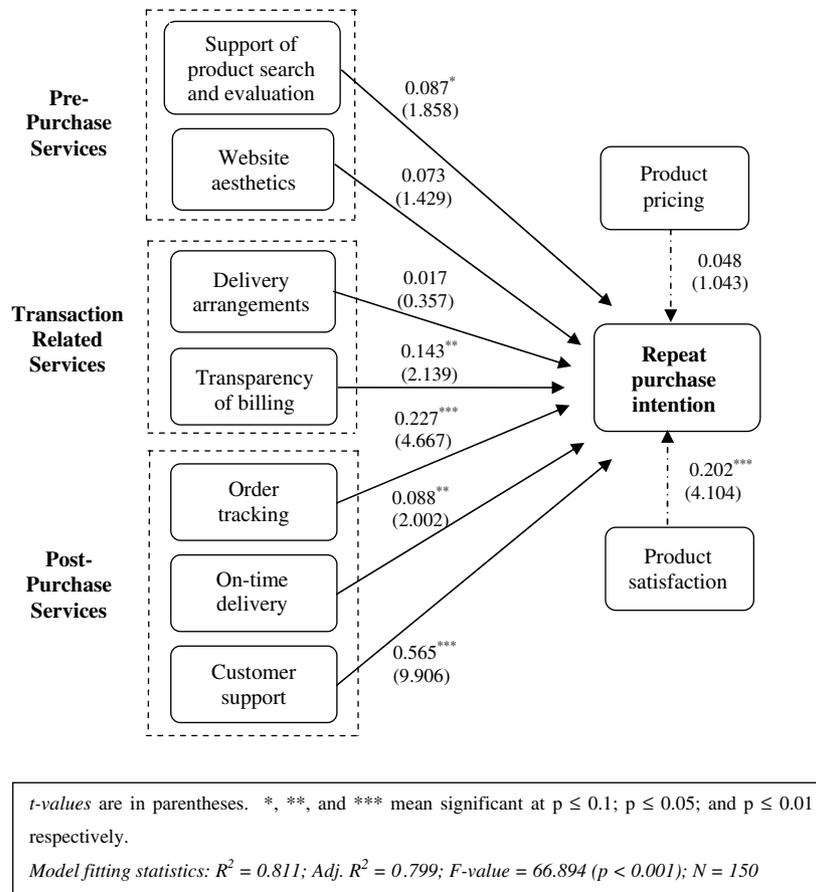


Figure 2 Regression results for effects of service dimensions on customer loyalty.

The results for control variables indicate that product satisfaction ($\alpha_9 = 0.202$, $t = 4.104$) is an important determinant of customer repeat purchase intention while product pricing ($\alpha_8 = 0.048$, $t = 1.043$) has no significant effect. These results imply that unlike the first generation e-commerce, product satisfaction supersedes price as a determinant of the likelihood of repeat purchases and hence long-term loyalty. Price may be important in initially attracting customers, but if they are not satisfied with the product or they are not provided good customer service and other post-purchase services, it will be hard to attract them back (Reibstein, 2002).

Discussion

This study tests the effects of various Web-based service dimensions on customer repeat purchase intention from a given online store in the context of computer purchases. In doing so, it addresses the weaknesses inherent in previous studies in several ways. First, it is about purchasing from a specific store rather than about buying on the Web in general (to buy online or not). Second, it uses a more comprehensive list of Web-based service dimensions than most previous empirical studies trying to investigate the relationship studied. Third, it uses data based on actual customer purchase experiences.

The main contribution of this study is the streamlining of Web-based services into pre-purchase, transaction-related, and post-purchase services, which made it possible to test their individual effects on customer loyalty. Based on this categorization, post-purchase services emerged as the key determinants of customer repeat purchase intention from an online store. By adopting a richer Web-based service framework, this study has taken one of the first steps to determine what might be the most important service dimension in an online context. This approach is useful from a practical perspective as it pinpoints to managers the aspects of service they ought to focus on.

Before we present the lessons learnt, the main findings of this study are briefly discussed below based on the conceptualized service categorization.

Pre-purchase services

Customer evaluation of a given Web-based store's support of product search and evaluation features has a minimal positive influence on their repeat purchase intention from that store, possibly because these were the services first targeted and implemented for e-commerce. Given the ubiquitous nature of these functionalities in commercial Websites, it may be difficult for companies to derive significant distinctive customer value from their use. Customers now view these functionalities as standard and necessary components of Websites that play a minimal distinctive role in influencing their repeat purchase intentions. Customer evaluation of Web esthetics does not influence their repeat purchase intentions. While this may contribute to shopping enjoyment (Koufaris *et al.*, 2001; Koufaris, 2002), it appears that

customers are more concerned about meeting their material shopping needs. These results confirm the assertion that online customers are goal-oriented. Goal-oriented customers are more interested in Web-based stores that meet their shopping needs efficiently and effectively and are not motivated by shopping enjoyment. They are more concerned with increased freedom and control and value attributes such as convenience and accessibility, selection, availability of information, and lack of sociality (Wolfenbarger & Gilly, 2001). Overall, satisfaction with services, not fun, may be the more important antecedent in forming a commitment to an e-business (Thatcher & George, 2004).

Transaction-related services

We would expect customer evaluation of delivery arrangements provided by a Web-based store to have no significant effect on repeat purchase intention when all Web stores use the same delivery options. As a result, there is no distinctive customer value, any of them can reap from this service. The real differentiator of customer value is whether the shipment is delivered on time regardless of the shipping option chosen (Reibstein, 2002). Our results also support the anecdotal evidence that customers are more likely to abandon a purchase due to hidden costs and shun Websites without transparent billing procedures (CIO Magazine, January 2004). Customers are concerned about total product acquisition costs before order submission, since this helps them assess the overall fairness of the costs of product acquisition from a given vendor relative to other vendors for similar products.

Post-purchase services

The results for post-purchase services support the notion that customers demand more control and convenience in online shopping environments (Koufaris *et al.*, 2001). Given that customers cannot physically handle the product and carry it home after an online purchase, support of order tracking removes uncertainty about the online order process and gives customers some sense of control about the status of their orders. Order tracking also provides more convenience than a service hotline from which customers could inquire about the status of their orders.

Customer evaluation of a Web-based store's performance on stated delivery time positively influences repeat purchase intention. Reliably fulfilling the order on time is very important to customers. Failing to do so undermines the convenience of online shopping and has negative implications on customer repeat purchase intention (Reibstein, 2002; Thatcher & George, 2004). Furthermore, companies that perform better at providing post-purchase customer support (e.g., information on problem troubleshooting, upgrades, maintenance, etc.) through their Website, are likely to build strong relationships with their customers and foster customer retention. Overall, these results are highly consistent with the observation by Ariely & Carmon (2000) that the part of the shopping experience the customer faces at the end of

the purchase process has the greatest influence on the likelihood to repeat purchase.

Lessons learnt

The empirical findings from this study offer some lessons learnt. In line with conventional thinking, we initially thought that Website design factors (e.g., overall look and feel of the site) might be the most important for online shoppers. However, the results were quite to the contrary as we offer the following lessons learnt:

- *It is not about the bells and whistles of Website design:* Quite often, companies are drawn into thinking that flashy Websites with lots of multimedia are necessary to attract customers and keep them coming back. However, goal-oriented customers are more concerned about shopping efficiency and not shopping enjoyment.
- *Search mechanisms may be too much of a good thing:* Companies often focus on search mechanism and recommender systems that help customers search and evaluate products, and furnish them with the necessary information to make a purchase. However, the results from this study imply that while these functionalities are somewhat important, focusing on them is not a strong strategy for customer retention and companies may be doing too much of a good thing.
- *Customers value transparency:* Using tactics to try to generate a sale is not a winning strategy. Firms that engage in information hiding and presentation tricks (like not showing hidden costs until it is too late) are following a short-term mind set that will be detrimental to their long-term viability.
- *Timely delivery is more important than delivery options.* It is easy for any company to provide several delivery options for products purchased online. However, the real service differentiator from the customer's perspective is timely delivery.
- *If you build it they will come – or will they?* Companies that are focused on just mere Web presence as a point-of-sale are short sighted. In the competitive world of e-commerce, establishing relationships with customers is more important than trying to make a one-time sale. Post-purchase services are particularly important in fostering customer relationships since they are tied to product ownership. Results from this study imply that satisfaction with product ownership experience is instrumental in generating repeat purchases.

Theoretical contribution

Following calls for further research to explore the nature of the groups of factors that determine Internet shopping behavior (Elliot & Fowell, 2000), this study emphasizes the concept of augmented service for the different phases of product acquisition and use by customers. This view about services is particularly applicable to the product market where the service itself is not the end product. By integrating a phased augmented service conceptualization with the TRA, this study provides a richer theoretical

perspective for the study of online customer loyalty behaviors. TRA informs on *why* certain behaviors are observed while phased augmented services are *what* lead to those behaviors in the context of e-commerce.

Practical implications

Business enterprises are often looking for ways to promote customer retention and consequently enhance long-term growth. In B2C e-commerce transactions, companies are usually concerned about service offerings that strengthen their relationship with customers and hence lead to customer loyalty. In view of the lessons learnt presented above, Web-based companies can implement some strategies to position themselves better in the e-commerce marketplace.

- (1) Overall, the service oriented framework and associated services used in this study alert companies to the importance of following an integrated approach to managing a customer's relationship. Each phase of a customer's relationship has a distinct value associated with it. Companies can convert this value into loyalty and financial performance by channeling appropriate services that enhance overall customer relationship.
- (2) Specifically, post-purchase services are the most important in fostering customer loyalty. Pre-purchase services seem to reflect more of a 'competitive necessity' rather than a source of differential advantage. Innovation in Web services should thus focus on the point at which the customer relationship becomes exclusive – subsequent to the purchase point. This is the opportunity for companies to view this as the beginning of a relationship rather than the end of a purchase. A challenge for Web-based companies is how to incorporate into their Websites post-purchase customer service and support. Furthermore, it is important that firms continue to evaluate and innovate in Web-based services, since service differentiators can be imitated and rapidly become competitive necessities.
- (3) The fact that transparency in billing is related to loyalty seems to suggest that trust in the relationship is fundamental to its longevity. Trust generally decreases the perceived risk of using a service, and its role could be more important in an e-commerce setting where face-to-face interactions are limited. Therefore in the provision of Web services, companies can build trust through transparent information presentation.

It should be noted that even though our focus has been on customer service, a holistic approach that articulates a strong value proposition that includes these services as well as a company's product offering will foster customer loyalty and long-term firm performance.

Some companies are already taking heed of this and experiencing repeat customer patronage as a result. For example, both Netflix (netflix.com) and Newegg

(newegg.com) integrate product offerings and excellent service, including an easy way to select products and fast delivery. Netflix delivers products to over 90 percent of its customers within one business day, while Newegg does so for nearly 98 percent of its customers. Both companies enjoy high levels of customer loyalty and the associated financial benefits, and receive high ratings from the popular press (e.g., Internet Retailer Magazine rates both companies in the 40 top-selling online retail sites). According to BizRate ratings, Newegg enjoys excellent customer rating for post-purchase service as well as transparency of billing – dimensions we found to be more important in our empirical findings. As a result, Newegg also receives an excellent repeat purchase intention rating. Similarly, other top-selling online retail stores profiled by Internet Retailer Magazine, such as Amazon (amazon.com) and QVC (qvc.com), excel at product selection and post-purchase service (according to BizRate ratings) and consequently enjoy excellent customer repeat purchase intention ratings. QVC is rated highly by customers across all the three post-purchase services (order tracking, on-time delivery, and customer support), while Amazon is more highly rated for order tracking, and Netflix and Newegg for fast delivery.

Conclusions

This study addresses the role of customer service in B2C e-commerce transactions. This is a topic of practical concern because customer service influences loyalty behavior; and customer retention is believed to be a key driver of firm profits (Anderson & Mittal, 2000). While online customer service has attracted the attention of both researchers and practitioners, there is no unified view on the most important dimensions and most of the studies are at the conceptual level. Furthermore, extant empirical studies have examined only a subset of Web-based service dimensions (e.g., support of product search and evaluation) and are therefore limited in scope. This study investigates how different types of Web-based services, that is, pre-purchase, transaction-related, and post-purchase services, influence customer repeat purchase intentions. These service categories follow from the concept of augmented service, which involves providing the customers with additional support related to the acquisition and use of the product by targeting the various activities that customers will be engaged in.

Most conventional thinking on e-commerce puts emphasis on Website design (e.g., search mechanisms, recommender systems, site esthetics, etc.) as the important dimension of Web-based service delivery. However, this study finds that services that support product search and evaluation have a weaker effect on customer repeat purchase intentions than post-purchase services (e.g., customer support) have. Although pre-purchase and transaction-related services are somewhat important, Web-based companies can foster customer loyalty by focusing mainly on post-purchase customer service dimensions, especially customer support. Given that

post-purchase service dimensions are tied to product ownership, it seems that the satisfaction with product ownership experience is instrumental in generating repeat purchases. Therefore, companies that are not just interested in generating a sale but rather in building relationships with their customers are likely to experience repeat purchases. Those that recognize this can effectively differentiate themselves in the competitive e-commerce marketplace.

Limitations and further research

This study has some limitations. First, the ratings were self-reported by customers willing to complete surveys after product purchase. Since the survey was not randomly assigned to respondents, the results may have been biased toward customers who are willing to answer surveys. Another potential limitation of this study is that the results may be limited to computer purchases, and thus cannot be generalized. This is a common risk of empirical studies of a single product. For example, effect of post-purchase services such as customer support may be higher, on average, for computers than for nontechnical and nondurable consumer goods.

Given that the findings in this study pertain to computers, further research should address other durable products as well as nondurable transactions goods. Research might establish that customers behave differently for durable products *vis-à-vis* nondurable ones. It could be that pre-purchase decision aids replete in e-commerce apply more to transactions-type, nondurable products while post-purchase Web services may apply more to durable goods. Insightful findings could guide online stores in developing and deploying customer decision support systems and customer service initiatives appropriate for their line of business.

Future research can also examine the capabilities needed for offering Web-based services. How do firms configure their infrastructure and other resources in order to create services that are difficult to imitate, due to their interaction with unique attributes of the firm? Further downstream, it would be of interest to investigate the effect of customer loyalty on customer value to the company and the impact of customer value on organizational performance. Knowing which customers are the most valuable allows a company to follow the important customer-centered concept outlined by Pine *et al.* (1995) for achieving increased share of customer wallet instead of increasing share of market. This is desirable because increasing the share of customer wallet is much more profitable than the price manipulation and discounting associated with attempts to increase market share.

This study used repeat purchase intention (behavioral intent) as a measure of customer loyalty. Further research could look at longitudinal data and track actual repeat purchase (actual behavior, not behavioral intent) as a measure of customer loyalty. This might generate some interesting insights about the relationship between customer attitudes and customer behavior over time.

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Appendix A

Explanation of BizRate's dimensions

Dimension	Explanation
Ease of finding what you are looking for	How easily the customer found the product he/she was looking for
Clarity of product information	How clear and understandable was the product information
Prices relative to other online merchants	Prices relative to other websites
Overall look and design of site	Overall look and design of the site
Variety of shipping options	Desired shipping options were available
Charges stated clearly before order submission	Total purchase amount (including shipping/handling charges) displayed before order submission
Order tracking	Ability to track orders until delivered
On-time delivery	Product arrived when expected
Product met expectations	Correct product was delivered and it worked as described/depicted
Customer support	Availability/ease of contacting, courtesy & knowledge of staff, resolution of issue
Would shop here again	Likelihood to buy again from this store

Appendix B

BizRate.com’s data gathering questionnaire

Please rate your purchase experience with this merchant’s Website. Please keep the following in mind when reviewing this store:

1. Provide specific, relevant information about this on-line purchase experience
2. Stick to the facts and try to be as accurate as possible
3. Only write a review after you have/were scheduled to receive the product.

Online ordering process

												
Rating scale	1	2	3	4	5	6	7	8	9	10	n/a	
Ease of finding what you are looking for	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Selection of products	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Clarity of product information	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Price relative to other online merchants	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Overall look and design of the site	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Variety of shipping options	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Charges stated clearly before order submission	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

Delivery/fulfillment of your online order

												
Rating scale	1	2	3	4	5	6	7	8	9	10	n/a	
Order tracking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
On-time delivery	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Product met expectations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Customer support	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

Overall satisfaction

												
Rating scale:	1	2	3	4	5	6	7	8	9	10	n/a	
Would shop here again	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	

Poor , Satisfactory , Good , Outstanding .

Appendix C

Detection of multicollinearity

The procedures for detecting multicollinearity (MC) outlined here are based on the works of Belsley *et al.* (1980) and Neter *et al.* (1990).

Variance inflation factor (VIF) VIF is an index of the inflation of the variance of each regression coefficient relative to a situation in which all of the predictor variables are uncorrelated. $VIF = 1/(1-R_i^2)$, where R_i^2 is the unadjusted R^2 when independent variable X_i is regressed against the remaining independent (explanatory) variables in the model. A common rule of thumb is to take $VIF > 10$ as an indication that MC may be a problem.

Tolerance

Tolerance is an index of how much the variance in X_i is independent of other predictor variables. It is the reciprocal of VIF, that is, $Tolerance = 1/VIF = 1-R_i^2$. Tolerance value of 0.10 or less indicates that there may be serious problems of MC in the regression model.

Condition indices Condition index $(IC) = \sqrt{(\lambda_{max}/\lambda_i)}$, where λ_{max} is the largest eigenvalue and λ_i is the i th subsequent eigenvalue. The eigenvalues are produced by decomposing the correlation matrix of the independent variables into a set of orthogonal dimensions. Here, we report only the largest CI value, also known as condition number (CN). $CN = \sqrt{(\lambda_{max}/\lambda_{min})}$ and the rule of thumb is that $CN \geq 30$ indicates severe problems of MC.

Multicollinearity test results

Variables	Tolerance	VIF
Support of product search and evaluation	0.620	1.613
Store atmospherics	0.517	1.935
Shipping options	0.612	1.635
Billing mechanism	0.301	3.318
Order tracking	0.567	1.763
On-time delivery	0.693	1.443
Customer support	0.414	2.413
Product pricing	0.632	1.581
Product satisfaction	0.554	1.806
Condition number (CN) = 9.477		

Appendix D

Correction of heteroscedasticity

When the form of heteroscedasticity is unknown, the HCCM provides a consistent estimator of the covariance matrix of the slope coefficients in the presence of heteroscedasticity. To correct for heteroscedasticity, we use HCCM approach developed by White (1980) and later modified for smaller sample sizes ($N < 250$) by MacKinnon & White (1985). Generally, HCCM is a procedure recommended for sample sizes of at least 100 observations.

Given a linear regression equation (in matrix notation): $\mathbf{y} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}$, where \mathbf{y} and $\boldsymbol{\varepsilon}$ are $N \times 1$ matrixes, \mathbf{X} is $N \times K$, and $\boldsymbol{\beta}$ is $K \times 1$ (N is sample size and K is number of explanatory variables). For the i th row of \mathbf{X} , we can write: $y_i = x_i\boldsymbol{\beta} + \varepsilon_i$. The usual OLS estimator $\hat{\boldsymbol{\beta}} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{y}$ has the covariance matrix: $\text{Var}(\hat{\boldsymbol{\beta}}) = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\boldsymbol{\Phi}\mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}$, where $\boldsymbol{\Phi}$ is a diagonal matrix with $\phi_{ii} = \text{var}(\varepsilon_i)$. The covariance matrix of the OLS estimator applies only if the errors are homoscedastic. In the presence of the usual case

of unknown heteroscedasticity ($\boldsymbol{\Phi}$ is unknown), we need a consistent estimator of $\boldsymbol{\Phi}$ in order to compute the covariance matrix of the OLS estimator. Defining the residuals $e_i = y_i - x_i\hat{\boldsymbol{\beta}}$, White's (1980) HCCM is based on the idea that e_i^2 can be used to estimate ϕ_{ii} . This can be thought of as estimating the variance of the error using a single observation: $\hat{\phi}_{ii} = (e_i - 0)^2 / 1 = e_i^2$. Then, let $\hat{\boldsymbol{\Phi}} = \text{diag}[e_i^2]$, which results in the estimator: $\text{HCCM} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\hat{\boldsymbol{\Phi}}\mathbf{X}(\mathbf{X}'\mathbf{X})^{-1} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\text{diag}[e_i^2]\mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}$.

As shown by White (1980) and others, HCCM is a consistent estimator of $\text{Var}(\hat{\boldsymbol{\beta}})$ in the presence of heteroscedasticity of an unknown form. It is recommended that a small sample size version of the HCCM should be used for sample sizes less than 250 observations. Since our sample size was 150 observations, we used a small sample size variation of the HCCM suggested by MacKinnon & White (1985), which is an approximation of Efron's jackknife estimator.