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The Effects of Logistics Service Quality on Perceived Sustainability, Logistics Value, and Customer Loyalty: Evidence from the Coupang Platform

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Abstract

Purpose: This research explores how logistics service quality (LSQ) influences perceived sustainability, logistics value, and customer loyalty. Using structural equation modeling (SEM), the study examines how LSQ dimensions shape customers' sustainability perception and how these perceptions contribute to value and loyalty. **Research design, data and methodology:** A model was developed from prior LSQ and sustainability studies. Survey data from 282 e-commerce consumers were analyzed with SEM. Constructs included order quality, delivery quality, information quality, customer service, and flexibility as LSQ dimensions, with perceived sustainability, logistics value, and loyalty as dependent variables. **Results:** Findings showed that delivery quality, customer service, and flexibility significantly enhance perceived sustainability, while order quality and information quality do not. Delivery quality, information quality, customer service, and flexibility also positively affect logistics value, whereas order quality remains insignificant. Perceived sustainability improves logistics value and directly influences customer loyalty, with logistics value showing the strongest effect. **Conclusions:** Customers recognize sustainable logistics practices through reliable delivery, responsive service, and flexibility, which reinforce loyalty. This study contributes to logistics and sustainability research by proposing an integrated framework linking service quality, sustainability perception, value, and loyalty. It also addresses the limitations of SERVQUAL by reframing LSQ dimensions for digital logistics platforms, offering both theoretical contributions and practical guidance for managers seeking competitive advantage.

Keywords: Logistics Service Quality, Perceived Sustainability, Logistics Value, Customer Loyalty, E-commerce Logistics, Coupang Platform

JEL Classification Code: L81, M31, Q56

1. Introduction

The advancement of information and communication technologies has enabled consumers to purchase goods without constraints of time and space. Since the 2010s, the widespread use of smartphones has accelerated the shift from PC-based to mobile platforms, driving a rapid increase in e-commerce transactions and logistics demand. Major

Korean e-commerce firms have actively invested in logistics infrastructure to secure competitive advantages through fast and accurate delivery services. Consequently, differentiated delivery models such as dawn delivery, same-day delivery, and rocket delivery have been introduced (Agatz et al., 2008). These ultra-fast delivery services have become not merely supplementary, but critical factors that determine firms' competitiveness (Mentzer et al. 2001).

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Coupang transformed the domestic retail market by launching rocket delivery in 2014. Unlike traditional hub-based systems, rocket delivery directly purchases and stores goods in fulfillment centers and delivers them to consumers without intermediate hubs, thereby enabling next-day delivery (Suh & Kim, 2022). Subsequently, other models such as Market Kurly's dawn delivery and SSG.com's quick delivery emerged, intensifying competition in the Korean e-commerce market. Recent statistics confirm this trend, with mobile shopping accounting for 75.1% of all online transactions in January 2025 (Statistics Korea, 2025).

E-commerce platforms are generating differentiated services through artificial intelligence (AI), automation, data-driven demand forecasting, and sustainable logistics practices. Prior studies indicate that eco-friendly logistics services enhance customer satisfaction and loyalty (Lin & Huang, 2012), while sustainable practices strengthen customer trust and long-term relationships (Wang et al. 2018). Positive perceptions of corporate sustainability further influence perceived value and repurchase behavior (Testa et al., 2020). Reflecting these trends, Coupang has improved logistics efficiency through AI-based demand forecasting, automated guided vehicles, and eco-friendly packaging, while also enhancing its sustainability image by addressing labor conditions.

LSQ is defined as a key criterion through which customers perceive and evaluate the value of service providers (Yang et al. 2010). Numerous studies have shown that LSQ significantly influences customer satisfaction, and customer loyalty (Fernandes et al., 2018; Huma et al., 2020). Considering that the success of online shopping in Korea heavily depends on repurchase rates and loyalty (Kim et al., 2012), LSQ and perceived sustainability are directly linked to sustainable competitiveness. However, prior research on service quality has been primarily based on the SERVQUAL (Parasuraman et al., 1988), which focuses on traditional dimensions such as reliability, responsiveness, and empathy. This framework does not adequately capture the unique features of digital logistics platforms, including ultra-fast delivery, AI-driven systems, and ESG-based sustainability.

Accordingly, this study reconstructs LSQ in the context of Coupang's platform using an extended model and investigates the effects of LSQ on customers' perceived sustainability, perceived logistics value, and customer loyalty. Theoretically, the study advances LSQ research by integrating sustainability into a digital logistics framework and demonstrating differential effects among LSQ dimensions. Managerially, it provides evidence-based guidance for e-commerce firms to enhance competitiveness by aligning logistics operations with both efficiency and sustainability imperatives.

2. Literature Reviews

2.1. Logistics Service Quality

Logistics service quality (LSQ) extends the concept of service quality to logistics activities, with definitions and measurement dimensions varying across scholars. Conrath and Mignen (1990) defined LSQ as the gap between customer expectations and actual services, emphasizing its role as a determinant of satisfaction. Similarly, Zeithaml et al. (1988) described service quality as the difference between expectations and perceptions, highlighting that in digital retail environments such as e-commerce, logistics service levels directly determine satisfaction. In Korea, Yoon (2011) defined logistics services as encompassing the entire process from order receipt to final product delivery, suggesting that LSQ represents the competencies delivered across these processes.

The theoretical foundation of service quality measurement originates from SERVQUAL (Parasuraman et al., 1988), which identifies five dimensions: tangibility, responsiveness, reliability, empathy, and assurance. While this model has been widely applied, logistics services differ fundamentally from typical services. Unlike general services, which are produced and consumed simultaneously with customer participation (Zeithaml et al., 2018), logistics services are physically separated and revolve around tangible goods. Therefore, outcome quality is particularly critical in logistics (Mentzer et al., 2001).

Since the mid-1990s, LSQ measurement tools have been developed from a marketing perspective. Mentzer et al. (2001) proposed nine dimensions, including personal contact quality, order release quantities, information quality, ordering procedures, order accuracy, order condition, order quality, order discrepancy handling, and timeliness. Huang et al. (2009) later refined LSQ into five dimensions: information quality, timeliness, ordering procedures, order condition, and discrepancy handling. With the rise of e-commerce, Collier and Bienstock (2006) emphasized the importance of delivery reliability and speed, while Boyer and Hult (2005) confirmed that delivery timeliness significantly influences satisfaction and loyalty.

The importance of last-mile delivery has also been highlighted. Esper et al. (2003) argued that last-mile strategies affect satisfaction and repurchase intention, while Agatz et al. (2008) emphasized flexible delivery and timeliness management in e-fulfillment. Reverse logistics further emerged as critical; Rogers and Tibben-Lembke (1999) conceptualized reverse logistics, and Mollenkopf et al. (2007) noted that simple and fast return processes significantly shape customer experience.

More recently, digital technology has become a key driver. Klaus (2013) highlighted Amazon's practices,

showing that real-time tracking, mobile notifications, and platform-based information quality improve logistics satisfaction. Addae et al. (2024) stressed the role of multichannel integration quality and service convenience in enhancing perceived value in multichannel settings.

In sum, LSQ has evolved from a simple expectation–perception gap into a multidimensional, customer experience-oriented construct shaped by e-commerce growth, last-mile delivery, reverse logistics, and digital technologies. For platforms like Coupang, speed, flexible delivery, convenient returns, and real-time information are critical LSQ dimensions driving competitive advantage.

2.2. Perceived Sustainability

Perceived sustainability refers to the extent to which customers evaluate a firm's products, services, and operations as pursuing sustainability across environmental, social, and economic dimensions (Testa et al., 2020). In the fields of e-commerce and logistics services, sustainability has emerged as a core factor shaping consumers' purchase decisions and loyalty, rather than being a purely ethical value (Wang et al., 2018).

Elkington's (1997) Triple Bottom Line (TBL) framework divides sustainability into three dimensions: environment, society, and economy. Building on this, subsequent research has measured consumers' perceptions of sustainability in multidimensional terms. Specifically, the environmental dimension includes eco-friendly packaging, carbon reduction, and recyclable materials; the social dimension involves safe working conditions, fair labor, and community contributions; and the economic dimension covers cost efficiency and long-term supply chain stability (Carter & Rogers, 2008).

Some studies have employed a unidimensional approach. Testa et al. (2020), for example, used consumers' holistic evaluation of a firm as "sustainable" as a single indicator, while Rao and Holt (2005) also applied a unidimensional perception in their study of green supply chain management in Asian firms. Conversely, Lin and Huang (2012) examined perceived sustainability in supply chains with a focus on environmental activities, and Wang et al. (2018) treated sustainability as a multidimensional construct when analyzing value drivers in sustainable logistics services.

Empirical evidence shows that perceived sustainability strongly influences consumer behavior. Lin and Huang (2012) found that green logistics services enhance satisfaction and loyalty, while Wang et al. (2018) showed that sustainable logistics practices positively affect perceived value and service adoption. Testa et al. (2020) further demonstrated that environmental practices contribute to favorable attitudes and long-term relationships through stakeholder pressures and social evaluations.

Accordingly, this study defines perceived sustainability as a key variable explaining the relationships among LSQ, logistics value, and customer loyalty. In line with prior research showing consumers' tendency to form holistic rather than dimension-specific evaluations, perceived sustainability is measured as a unidimensional construct. This approach minimizes model complexity while capturing consumers' overall assessment. Coupang's initiatives—including AI-based demand forecasting, automation, eco-friendly packaging, carbon reduction, and improved labor practices (Suh & Kim, 2022)—are expected to strengthen customers' perceptions of sustainability, serving as a mediator that links LSQ to perceived value and customer loyalty.

2.3. Logistics Value

Logistics value is defined as customers' overall evaluation of the utility and benefits derived from logistics services, extending beyond cost reduction to encompass satisfaction and long-term relationship building (Flint et al., 2005; Mentzer et al., 2001). It represents a trade-off between the benefits received and the costs paid to obtain them.

Early studies conceptualized logistics value mainly in terms of cost efficiency (Novack et al., 1992). Later, researchers extended it to a multidimensional construct rooted in customer experience. Stank et al. (1999) demonstrated that logistics value contributes to satisfaction and long-term relationships, while Mentzer et al. (2001) clarified its strong link to LSQ. In e-commerce, Richey et al. (2005) reported that consumers perceive logistics as a core value-creation element, and Esper et al. (2003) showed that last-mile strategies enhance perceived logistics value and satisfaction.

Multiple dimensions of logistics value have been identified, including time, reliability, information, flexibility, service recovery, and cost (Novack et al., 1992; Mentzer et al., 2001). Time value refers to timeliness and speed, reliability value to order accuracy and consistency, information value to tracking and accuracy, flexibility value to delivery options and responsiveness, service recovery value to problem-solving in delays or returns, and cost value to reasonable pricing and reduced return costs. Recent studies highlight these factors not only as efficiency drivers but also as mediators of repurchase intention and loyalty (Flint et al., 2005; Wang et al., 2018).

At the same time, some studies adopt a unidimensional perspective. Flint et al. (2005) defined logistics value as a single indicator of customers' perceived overall benefits, while Testa et al. (2020) measured sustainability similarly as a holistic evaluation. Rao and Holt (2005) also applied a unidimensional assessment of sustainability in Asian firms. These approaches suggest that consumers often evaluate

logistics value and sustainability holistically rather than by dimension. Thus, this study conceptualizes logistics value as a unidimensional construct to reflect customers' overall perceptions and to reduce model complexity, given that LSQ is already multidimensional. This approach allows a clearer examination of how logistics value influences customer loyalty in the e-commerce context.

2.4. Customer Loyalty

Customer loyalty refers to a consumer's tendency to maintain a favorable attitude and repeatedly purchase from a specific firm or brand, while resisting switching to competitors (Oliver, 1999). It has evolved into a multidimensional construct encompassing both attitudinal loyalty and behavioral loyalty (Dick & Basu, 1994). Attitudinal loyalty represents emotional attachment or psychological preference, while behavioral loyalty reflects repeated purchases, continuous usage, and positive word-of-mouth (Chaudhuri & Holbrook, 2001).

The link between service quality and loyalty has been widely validated. Parasuraman et al. (1988) argued that reliability, responsiveness, and empathy affect loyalty through satisfaction. Cronin and Taylor (1992) empirically demonstrated that service quality and satisfaction positively influence loyalty, while Zeithaml et al. (1996) confirmed that service quality directly affects behavioral intentions such as repurchase, recommendation, and willingness to pay price premiums. Similar findings have been observed in e-commerce. Anderson and Srinivasan (2003) emphasized the role of website and service quality in building e-loyalty. Cyr et al. (2006) also found that information quality and usability positively affect loyalty in online shopping. In logistics, delivery reliability and speed have been identified as key drivers of customer loyalty (Fernandes et al., 2018; Huma et al., 2020).

Research also shows the role of value in loyalty formation. Sirdeshmukh et al. (2002) highlighted the roles of trust and value perceptions, while Flint et al. (2005) argued that logistics value fosters long-term customer relationships. More recent studies emphasize perceived sustainability as a new driver of loyalty. Wang et al. (2018) showed that customers strengthen loyalty when they perceive eco-friendly logistics as valuable.

Accordingly, this study sets customer loyalty as an outcome variable of LSQ, perceived sustainability, and logistics value. This reflects the view that in online distribution platforms, service quality not only influences short-term repurchase but also contributes to long-term retention, positive word-of-mouth, and the formation of a loyal customer base.

3. Research Design

3.1. Research Model

This study develops a research model to examine how LSQ on the Coupang platform influences customers' perceived sustainability, logistics value, and ultimately, customer loyalty. Prior studies have highlighted service quality as a key antecedent of customer value and loyalty, while more recent research emphasizes the role of sustainability in shaping consumers' value perceptions and fostering long-term relationships.

Reflecting these insights, the present study conceptualizes LSQ as the independent variable, perceived sustainability and logistics value as mediating variables, and customer loyalty as the dependent variable. The proposed research model is illustrated in Figure 1.

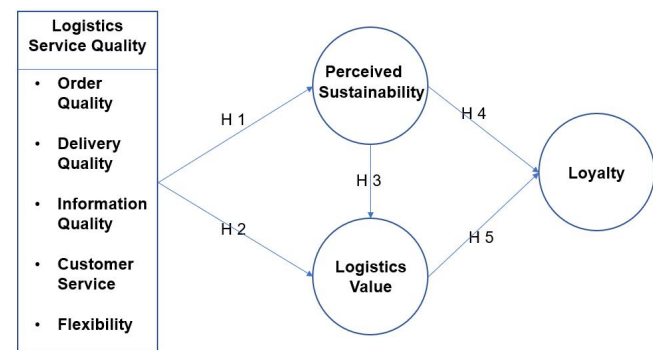


Figure 1: Research Model

3.2. Hypothesis Development

3.2.1. LSQ and Perceived Sustainability

LSQ encompassing attributes such as reliability, timeliness, information quality, and flexibility, has been identified as a critical driver of customer satisfaction and loyalty (Mentzer et al., 2001; Fernandes et al., 2018). Recent studies suggest that service quality extends beyond operational efficiency to influence perceptions of corporate responsibility and sustainability. Perramon et al. (2022) found that service quality and environmental practices jointly shape customer evaluations in the hotel industry. Similarly, Yingfei et al. (2022) reported that service quality enhances corporate image and trust, while Conte et al. (2023) demonstrated that reliability and service quality play important roles in stakeholders' sustainability evaluations. Xu et al. (2023) further highlighted that the credibility of CSR information directly affects customers' sustainability perceptions. Synthesizing these findings, customers who experience reliable and consistent logistics services are

more likely to perceive the firm as fulfilling its environmental and social responsibilities. Hence, LSQ can serve as a key antecedent of perceived sustainability.

H1: LSQ positively influences perceived sustainability.

3.2.2. LSQ and Logistics Value

LSQ is a key factor in evaluating logistics providers, including order accuracy, delivery reliability, timeliness of information, and responsiveness to problems (Mentzer et al., 2001). Logistics value, by contrast, represents the overall benefits and utility derived from logistics services, including not only cost savings but also time efficiency, convenience, reliability, and stability (Flint et al., 2005; Stank et al., 1999).

Previous studies consistently show that service quality precedes customers' value perceptions. Zeithaml (1988) argued that service quality directly influences perceived value. Cronin et al. (2000) confirmed that service quality affects behavioral intentions through perceived value and satisfaction. In logistics, Mentzer et al. (2001) emphasized LSQ as an antecedent of logistics value, and Stank et al. (1999) found that logistics performance enhances customers' value evaluations.

H2: LSQ positively influences logistics value.

3.2.3. Perceived Sustainability and Logistics Value

Perceived sustainability refers to the degree to which customers evaluate a firm as fulfilling environmental, social, and economic responsibilities (Testa et al., 2020). Recent studies highlight its significance in shaping value perceptions. Zhang et al. (2021) showed that consumers' positive perceptions of eco-friendly supply chain practices in the fashion industry influence satisfaction and purchase intentions. Rao and Holt (2005) argued that sustainable supply chain practices enhance competitiveness and customer-perceived value. Similarly, Wang et al. (2018) demonstrated that sustainable logistics services positively influence perceived value and adoption intentions. These findings suggest that customers evaluate logistics services as more valuable when they are delivered through environmentally and socially responsible practices.

H3: Perceived sustainability positively influences logistics value.

3.2.4. Perceived Sustainability and Customer Loyalty

Perceived sustainability reflects the extent to which customers believe firms fulfill environmental, social, and economic responsibilities (Testa et al., 2020; Yong et al., 2019). Prior studies show that customers who positively perceive sustainability initiatives are more likely to maintain

long-term relationships and exhibit loyalty. Sirdeshmukh et al. (2002) argued that trust and responsibility strengthen loyalty, while Perramon et al. (2022) reported that service quality and environmental practices jointly influence loyalty in hospitality. Wang et al. (2018) found that sustainable logistics services enhance adoption intentions and loyalty, and Conte et al. (2023) confirmed that credible sustainability signals improve stakeholders' evaluations and lead to positive behaviors. Thus, perceived sustainability functions as a critical driver of customer loyalty by fostering trust and long-term commitment.

H4: Perceived sustainability positively influences customer loyalty.

3.2.5. Logistics Value and Customer Loyalty

Logistics value is defined as the total evaluation of benefits derived from logistics services, extending beyond cost reduction to satisfaction and long-term relationship building (Flint et al., 2005; Mentzer et al., 2001). Attributes such as reliability, timeliness, and information transparency directly contribute to perceived value, which in turn leads to loyalty (Stank et al., 1999; Richey et al., 2005).

Customer loyalty refers to repeated purchase intentions and psychological attachment (Oliver, 1999), encompassing both behavioral and attitudinal dimensions (Dick & Basu, 1994; Chaudhuri & Holbrook, 2001). Sirdeshmukh et al. (2002) demonstrated that trust and perceived value strengthen loyalty. In logistics and e-commerce contexts, Fernandes et al. (2018) confirmed that LSQ-driven logistics value directly enhances loyalty. Thus, logistics value functions as a mediator that translates logistics performance into long-term customer loyalty.

H5: Logistics value positively influences customer loyalty.

3.3. Operational Definitions of Variables

Logistics Service Quality (LSQ) in the context of the Coupang platform is defined as the perceived gap between consumers' expectations and the actual services provided throughout the logistics process, from order placement to the final delivery of the product. Order Quality refers to the customer's perception of the accuracy, convenience, and system stability of the ordering process. Delivery Quality is defined as the customer's evaluation of the timeliness, accuracy, and condition of delivered products. Information Quality refers to the perceived accuracy, reliability, and real-time availability of delivery-related information. Customer Service is defined as the customer's evaluation of the courtesy of service representatives and delivery personnel, as well as the promptness of problem resolution. Flexibility refers to the degree to which the service can respond to

customer needs (e.g., changes in delivery time, location, or method) and provide a variety of options. LSQ was measured with a total of 20 items adapted to the Coupang logistics service context, based on prior studies (Mentzer et al., 2001; Yang et al., 2010; Wang & Zhang, 2023; Zeithaml et al., 1996; Richey et al., 2005).

Perceived Sustainability is defined as the overall level of perception by customers regarding the extent to which Coupang fulfills its environmental, social, and economic responsibilities. Measurement items were developed based on prior studies (Testa et al., 2018; Perramon et al., 2022; Conte et al., 2023; Yong et al., 2019), and a total of five items were employed.

Logistics Value refers to the overall evaluation of the benefits and utilities perceived by customers from Coupang’s logistics services in terms of time savings, cost efficiency, reliability, and convenience. In this study, logistics value was treated as a unidimensional construct and measured with five items, drawing on the works of Flint et al. (2005), Stank et al. (1999), and Mentzer et al. (2001).

Customer Loyalty is defined as the long-term attitudinal attachment and repeated usage intention that customers hold toward Coupang. Based on prior studies (Chaudhuri & Holbrook, 2001; Zeithaml et al., 1996), customer loyalty was measured with four items. The questionnaire items were adapted and refined from validated scales in previous studies to fit the research context. All key variables—logistics service quality, perceived sustainability, logistics value, and customer loyalty—were measured on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree).

3.4. Data collection and Research Method

This study surveyed consumers who had used Coupang’s logistics services within the past six months. Conducted in March 2025 through a professional online research agency, 300 questionnaires were distributed, and 282 valid responses were obtained (response rate: 94%). Data were analyzed with SPSS 26.0 and AMOS 26.0 using frequency analysis, confirmatory factor analysis (CFA), discriminant validity tests, and structural equation modeling (SEM) to examine the proposed hypotheses.

4. Results

4.1. Demographic Characteristics

The respondents’ demographic characteristics were examined using frequency analysis, and the results are presented in Table 1

Table 1: Demographic Characteristics of Respondents

Distinction		n	%
Gender	Female	167	59.2
	Male	115	40.8
Age	20~29	54	19.1
	30 ~39	88	31.2
	40~49	94	33.3
	Over 50	46	16.3
Education	High school graduate	53	18.8
	Associate degree	82	29.1
	Bachelor’s degree	134	47.5
	Graduate degree or higher	13	4.6
Usage Frequency Per month	Once or less	35	12.4
	2-4 times	142	50.4
	5 times or more	105	37.2
Total		282	100

4.2. Reliability and Validity

In this study, the internal consistency of the measurement items was assessed using Cronbach’s α coefficients. As shown in Table 2, all Cronbach’s α values exceeded the recommended threshold of 0.70, ranging from 0.776 to 0.934, thereby confirming satisfactory reliability. Confirmatory factor analysis (CFA) was then conducted to assess construct validity. The results indicated an acceptable model fit ($\chi^2 = 498.412$, $p < 0.001$; $\chi^2/df = 2.581$; GFI = 0.901; AGFI = 0.882; RMR = 0.029; NFI = 0.908; CFI = 0.937; IFI = 0.932; RMSEA = 0.052), consistent with the criteria suggested by Hair et al. (2010).

To examine convergent validity, squared multiple correlations (SMC), standardized factor loadings, and average variance extracted (AVE) were evaluated. Two items with SMC values below the 0.50 threshold were removed from the final model: “Coupang strives to improve employee working conditions and provide a safe workplace” (SMC = 0.438) under Perceived Sustainability, and “Overall, Coupang’s logistics service delivers significant benefits and value to me” (SMC = 0.462) under Logistics Value. After their removal, all standardized loadings exceeded 0.50, AVE values ranged from 0.507 to 0.798, and all t-values were greater than ± 1.96 , confirming convergent validity. Although two items were removed, the remaining indicators sufficiently captured the constructs, as evidenced by high CR and AVE values.

Composite reliability values further supported construct reliability, ranging from 0.792 (Customer Service) to 0.921 (Perceived Sustainability), all above the recommended 0.70 threshold. Discriminant validity was also established using the Fornell–Larcker criterion, as the square roots of AVEs were greater than inter-construct correlations in all cases (Fornell & Larcker, 1981).

Table 2: CFA for the Measurement Model

Factor	Measurement Category	Std. factor loading	t Value	SMC	AVE
Order Quality	OQ 1	.717	---	.559	.507
	OQ 2	.587	17.108**	.580	
	OQ 3	.736	17.407**	.584	
	OQ 4	.811	15.504**	.673	
Delivery Quality	DQ 1	.603	---	.801	.598
	DQ 2	.600	16.008**	.881	
	DQ 3	.612	16.701**	.682	
	DQ 4	.776	15.903**	.578	
Information Quality	IQ 1	.716	---	.768	.670
	IQ 2	.664	12.114**	.610	
	IQ 3	.854	12.897**	.821	
	IQ 4	.660	12.710**	.758	
Customer Service	CS 1	.819	15.307**	.587	.613
	CS 2	.781	---	.598	
	CS 3	.715	16.340**	.778	
	CS 4	.801	14.883**	.874	
Flexibility	FL 1	.753	---	.667	.538
	FL 2	.677	15.334**	.666	
	FL 3	.598	14.887**	.769	
	FL 4	.678	13.298**	.798	
Perceived Sustainability	PS 1	.753	---	.667	.512
	PS 2	.782	11.314**	.646	
	PS 3	.890	11.317**	.769	
	PS 4	.768	11.892**	.807	
Logistics Value	LV 1	.790	---	.790	.742
	LV 2	.887	11.298**	.718	
	LV 3	.768	12.729**	.601	
	LV 4	.796	13.211**	.578	
Loyalty	LO 1	.801	12.987**	.781	.798
	LO 2	.812	11.453**	.546	
	LO 3	.712	13.789**	.671	
	LO 4	.703	13.672**	.789	
Composite Reliability: Order Quality 0.865, Delivery Quality 0.854, Information Quality 0.903, Customer Service 0.792, Flexibility 0.836, Perceived Sustainability 0.921, Logistics Value 0.814, Loyalty 0.828					

4.3. Hypothesis test

Applying the proposed research model, this study examined the effects of LSQ on perceived sustainability, logistics value, and customer loyalty. Based on theoretical discussions, a structural model was established, and empirical analyses were conducted using structural equation modeling (SEM). The test of the overall structural model

indicated acceptable model fit: $\chi^2=498.412$ ($p<0.001$), $\chi^2/df=2.581$, GFI=0.901, AGFI=0.882, NFI=0.908, CFI=0.937, IFI=0.932, RMR=0.029, and RMSEA=0.052. Compared with the recommended thresholds suggested by Anderson and Gerbing (1988), the fit indices demonstrate that the model is proper and reliable for hypothesis testing (Table 4).

4.3.1. LSQ and Perceived Sustainability

Hypothesis 1 tested the effects of LSQ on perceived sustainability across five factors: order quality, delivery quality, information quality, customer service, and flexibility. Order quality ($\beta = 0.070, t = 1.273, p > 0.05$) and information quality ($\beta = 0.060, t = 1.200, p > 0.05$) were not significant, rejecting Hypotheses 1-1 and 1-3. In contrast, delivery quality ($\beta = 0.210, t = 4.038, p < 0.05$), customer service ($\beta = 0.140, t = 3.111, p < 0.05$), and flexibility ($\beta = 0.330, t =$

$4.231, p < 0.05$) had significant positive effects, supporting Hypotheses 1-2, 1-4, and 1-5.

Overall, delivery quality, customer service, and flexibility enhance sustainability perception, while order and information quality do not. This implies that consumers in digital e-commerce view order accuracy and information as basic expectations, giving greater weight to delivery reliability, service, and flexibility.

Table 3: Correlation Matrix

	A	B	C	D	E	F	G	H
Order Quality: A	.712							
Delivery Quality: B	.322	.773						
Information Quality: C	.425	.421	.818					
Customer Service: D	.457	.462	.341	.782				
Flexibility: E	.409	.296	.337	.387	.733			
Perceived Sustainability: F	.411	.381	.471	.321	.393	.715		
Logistics Value: G	.234	.341	.346	.532	.423	.237	.861	
Loyalty: H	.324	.337	.487	.502	.498	.411	.428	.893

Note: $p < 0.01$ (diagonal; square root AVE)

Table 4: Results of Hypothesis Testing

H	Path	Estimate	t-value	p-value	Decision
1-1	Order Quality -> Perceived Sustainability	0.070	1.273	.203	Rejected
1-2	Delivery Quality -> Perceived Sustainability	0.210	4.038	.000**	Accepted
1-3	Information Quality -> Perceived Sustainability	0.060	1.200	.230	Rejected
1-4	Customer Service -> Perceived Sustainability	0.140	3.111	.002**	Accepted
1-5	Flexibility -> Perceived Sustainability	0.330	4.231	.000**	Accepted
2-1	Order Quality -> Logistics Value	0.120	1.500	.134	Rejected
2-2	Delivery Quality -> Logistics Value	0.260	4.127	.000**	Accepted
2-3	Information Quality -> Logistics Value	0.150	2.727	.006**	Accepted
2-4	Customer Service -> Logistics Value	0.280	3.457	.001**	Accepted
2-5	Flexibility -> Logistics Value	0.170	2.833	.005**	Accepted
3	Perceived Sustainability -> Logistics Value	0.320	4.571	.000**	Accepted
4	Perceived Sustainability -> Loyalty	0.210	2.917	.004**	Accepted
5	Logistics Value -> Loyalty	0.510	6.000	.000**	Accepted

Note: ** $p < 0.05$

4.3.2. LSQ and Logistics Value

Hypothesis 2 examined the effects of LSQ on logistics value. LSQ consisted of five factors: order quality, delivery quality, information quality, customer service, and flexibility. Results showed that order quality ($\beta = 0.120, t = 1.500, p > 0.05$) was not significant, rejecting Hypothesis 2-1. In contrast, delivery quality ($\beta = 0.260, t = 4.127, p < 0.05$), information quality ($\beta = 0.150, t = 2.727, p < 0.01$), customer service ($\beta = 0.280, t = 3.457, p < 0.01$), and

flexibility ($\beta = 0.170, t = 2.833, p < 0.01$) all showed significant positive effects, supporting Hypotheses 2-2 through 2-5. Taken together, these findings suggest that delivery reliability, information quality, customer service, and flexibility significantly enhance logistics value, whereas order quality is viewed as a basic expectation and thus fails to generate additional value in platform-based contexts.

4.3.3. Perceived Sustainability and Logistics Value

Hypothesis 3 tested the effect of perceived sustainability on logistics value. The analysis showed that the path coefficient from perceived sustainability to logistics value was 0.320 ($t=4.571$), which was statistically significant at the 95% confidence level ($p < 0.05$). Therefore, Hypothesis 3 was accepted. This finding indicates that customers who perceive higher levels of sustainability in logistics services are more likely to recognize greater logistics value. In other words, sustainability-oriented logistics practices not only strengthen corporate image but also enhance the value customers attribute to logistics services.

4.3.4. Perceived Sustainability and Loyalty

Hypothesis 4 examined the effect of perceived sustainability on customer loyalty. The analysis showed that the path coefficient from perceived sustainability to loyalty was 0.210 ($t=2.917$), which was statistically significant at the 95% confidence level ($p < 0.05$). Therefore, Hypothesis 4 was accepted. This result suggests that when customers perceive sustainability practices positively in logistics services, their loyalty toward the service provider increases. It highlights the importance of embedding sustainability into logistics strategies as a means to strengthen long-term customer relationships.

4.3.5. Logistics Value and Loyalty

Hypothesis 5 tested the effect of logistics value on customer loyalty. The path coefficient from logistics value to loyalty was 0.510 ($t=6.000$), which was statistically significant at the 95% confidence level ($p < 0.05$). Thus, Hypothesis 5 was accepted. This finding demonstrates that customers who perceive higher logistics value are significantly more likely to remain loyal. In other words, when logistics services are perceived as valuable—through factors such as reliable delivery, responsive service, and operational flexibility—customers are more inclined to continue using the services and maintain long-term loyalty.

5. Conclusion

This study aimed to investigate the effects of LSQ on perceived sustainability, logistics value, and customer loyalty. Drawing upon previous studies in LSQ and sustainability research, hypotheses were established and tested through structural equation modeling. The empirical findings are summarized as follows.

First, the results showed that delivery quality, flexibility, and customer service significantly enhanced perceived sustainability, while order and information quality did not. This suggests that improving delivery reliability, functional

services, and customer support is crucial for sustainability perception. Although partially consistent with prior studies (e.g., Huma et al., 2020; Fernandes et al., 2018), the non-significance of order and information quality implies that in digital e-commerce environments these factors are taken for granted, with greater emphasis placed on delivery efficiency, reliability, and service support.

Second, in examining the relationship between LSQ and logistics value, delivery quality, information quality, customer service, and flexibility were found to significantly enhance logistics value, whereas order quality did not. These findings align with previous studies highlighting the importance of operational reliability and customer responsiveness in driving perceived value. However, the lack of significance for order quality diverges from traditional logistics literature (e.g., Mentzer et al., 2001), implying that in platform-based logistics contexts, customers may not perceive order accuracy alone as a value-enhancing element.

Third, the structural model results revealed that perceived sustainability had a significant positive effect on logistics value, which in turn significantly increased customer loyalty. Moreover, perceived sustainability also directly improved loyalty, though its effect was weaker than the mediating role of logistics value. These findings indicate that customers' awareness of sustainable logistics practices not only strengthens perceived logistics value but also fosters long-term loyalty.

This study makes several academic contributions to the literature on logistics and sustainable service management. First, by incorporating perceived sustainability into the LSQ framework, it extends prior research that primarily emphasized operational outcomes (e.g., timeliness, accuracy) or service satisfaction. This integration demonstrates that sustainability should be regarded not only as a corporate responsibility but also as a strategic dimension of service quality that influences customer perception and loyalty.

Second, the study provides empirical evidence of the differential effects of LSQ dimensions, showing that not all elements exert equal influence on sustainability perception, logistics value, or loyalty. For example, delivery reliability, customer service, and flexibility significantly contributed, whereas order quality and information quality did not. This nuanced finding advances theory by challenging the assumption of homogeneity among service quality factors and highlighting the context-dependent nature of their effects.

Third, by developing and validating an integrated structural model linking logistics service quality, sustainability, value, and loyalty, this study offers a comprehensive theoretical framework that broadens our understanding of sustainable logistics management. The

model highlights the mediating role of logistics value in translating sustainability perception into customer loyalty, thereby offering novel insights into the mechanisms through which sustainability initiatives create tangible customer outcomes. Finally, the study contributes to the emerging body of literature on sustainable consumer behavior in digital logistics platforms. As logistics increasingly operates in e-commerce and platform-based environments, this research provides a foundation for future theoretical work exploring how sustainability perceptions are shaped and how they affect long-term customer-firm relationships.

From a managerial standpoint, the findings provide several actionable insights. First, the empirical results showed that delivery quality, customer service, and flexibility significantly enhanced both sustainability perception and logistics value. Managers should therefore focus resources on strengthening these areas, as doing so directly supports customer loyalty. Simply providing accurate order processes or real-time information may no longer differentiate a firm in the eyes of customers, as these elements are increasingly taken for granted.

Second, the analysis confirmed that perceived sustainability not only improved logistics value but also had a direct effect on loyalty. This finding highlights the need for managers to explicitly link sustainability initiatives—such as eco-friendly packaging, carbon reduction strategies, and community engagement—to measurable customer outcomes. Positioning sustainability as a core element of service delivery, rather than a peripheral activity, is essential to achieving competitive advantage.

Third, the study showed that logistics value was the strongest predictor of customer loyalty. This suggests that transparent communication, secure information systems, and proactive customer engagement are critical for reinforcing value perceptions. Firms should invest in both technological infrastructure (e.g., tracking systems, secure platforms) and relational strategies (e.g., clear communication of sustainability achievements) to maintain credibility. Finally, the findings imply that logistics firms seeking long-term competitiveness must adopt a dual strategy: improving operational excellence (speed, reliability, flexibility) while simultaneously enhancing sustainability performance. This dual emphasis not only differentiates the firm in competitive markets but also fosters enduring customer loyalty by aligning with consumers' increasing expectations for responsible and sustainable logistics services.

Despite its contributions, this study has limitations. First, it focused on a limited set of LSQ factors; future research could explore additional dimensions such as technological innovation, payment security, or reverse logistics. Second, the sample was confined to users of a specific e-commerce platform, which may limit generalizability. Future research

should therefore extend the scope to cross-cultural contexts to test whether these relationships hold in diverse environments, and employ longitudinal designs to examine how LSQ and sustainability effects evolve over time. Third, while this study treated sustainability perception as a unidimensional construct, future research may consider multidimensional measures (economic, environmental, and social) to capture more nuanced effects.

Declarations

Ethics Approval and Consent to Participate

This research involved the use of existing survey data and was determined to be exempt from review by the Institutional Review Board of Seowon University in accordance with applicable regulations.

Competing Interests / Conflicts of Interest

The authors declare that they have no competing interests.

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Author Contributions

[Author 1]: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, review & editing. The author has read and approved the final manuscript.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the author used ChatGPT-4 (OpenAI) to improve the clarity and readability of the manuscript. After using this tool, the author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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