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Analysis of after-sales service quality and customer satisfaction in agricultural machinery using structural models

Análisis de la calidad del servicio postventa y satisfacción del cliente en maquinaria agrícola mediante modelos estructurales

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Jefferson Santos Panduro Escalera
https://orcid.org/0009-0007-3359-6049
jefferson.panduro@usil.pe
Universidad San Ignacio de Loyola. Lima, Peru

Godofredo Pastor Illa-Sihuincha
https://orcid.org/0000-0002-2532-3194
gilla@usil.edu.pe
Universidad San Ignacio de Loyola. Lima, Peru

Shelby Hubert Ramos Serrano
https://orcid.org/0000-0001-6377-0203
sramoss@usil.edu.pe
Universidad San Ignacio de Loyola. Lima, Peru

Abstract

This study analyzes the impact of after-sales service quality on consumer satisfaction within the agricultural machinery sector in Lima, Peru. The research employed a quantitative, explanatory approach, using a non-experimental, cross-sectional design. Data were collected through surveys administered to a probabilistic sample of 602 customers in the agricultural machinery sector. The analysis was performed using PLS-SEM structural equations. The proposed model included constructs such as tangibility, empathy, security, responsiveness, and trust, which showed significant effects on customer satisfaction. The results show that trust, security, and responsiveness in after-sales service are key determinants of customer satisfaction. These findings reaffirm that, in agricultural contexts where operational continuity depends on technical support, efficient after-sales service becomes a strategic tool for strengthening satisfaction. The research provides relevant evidence to the literature on service quality, especially in productive sectors with high technological demands, and offers practical recommendations for customer-oriented organizational management.

Keywords: services, consumer, agricultural machinery.

Resumen

Este estudio analiza el impacto de la calidad del servicio postventa en la satisfacción del consumidor dentro del sector de maquinaria agrícola en Lima, Perú. La investigación empleó un enfoque cuantitativo, de tipo explicativo, utilizando un diseño no experimental y transversal. Se recopilaron datos a través de encuestas aplicadas a una muestra probabilística de 602 clientes del sector de maquinaria agrícola. El análisis se realizó mediante ecuaciones estructurales PLS-SEM. El modelo propuesto incluyó constructos como tangibilidad, empatía, seguridad, capacidad de respuesta y confianza, los cuales mostraron efectos significativos sobre la satisfacción del cliente. Los resultados evidencian que la confianza, la seguridad y la capacidad de respuesta en el servicio postventa son determinantes clave en la satisfacción del cliente. Estos hallazgos reafirman que, en contextos agrícolas donde la continuidad operativa depende del soporte técnico, un servicio postventa eficiente se convierte en una herramienta estratégica para fortalecer la satisfacción. La investigación aporta evidencia relevante a la literatura sobre calidad de servicio, especialmente en sectores productivos con alta exigencia tecnológica, y plantea recomendaciones prácticas para la gestión organizacional orientada al cliente.

Palabras clave: servicios, consumidor, maquinaria agrícola.

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Introduction

Despite the growing interest in service quality and its relationship with customer satisfaction in commercial sectors (Amro et al., 2025; Uzir et al., 2021), there exists a significant gap in the literature regarding the quality of post-sale service in the agricultural machinery marketing sector. Although recent studies have addressed general aspects of customer satisfaction across various industries, few have specifically focused on the agricultural context, where the nuances of post-sale service can critically influence the customer experience. Research such as that conducted by González et al. (2024) has explored service quality in industrial settings, but has not applied specific models that consider the dynamics of the agricultural market. Furthermore, the lack of studies employing predictive causal approaches in this field limits a deep understanding of how post-sale service quality variables interrelate and affect customer satisfaction for these types of goods (Cayo-Velásquez et al., 2025).

The accelerated modernization of agriculture in Latin America, particularly in Peru, has driven the demand for technological solutions that optimize productivity (Montes de Oca & Castañón, 2025). In this context, post-sale service gains strategic relevance, as inefficient dispatch or inadequate technical support can lead to costly delays affecting the production chain (Dabic-Miletic & Knezevic, 2024). In an environment where the pace of innovation and global competition is relentless, ensuring excellent post-sale service becomes a critical differentiating factor (Hussein et al., 2022). Additionally, the ability to provide timely and reliable post-sale dispatch that fosters customer trust is crucial for consolidating long-term relationships and enhancing reputation (Asha et al., 2023). The experience of purchasing agricultural machinery, the technical support provided, and the promptness of post-sale dispatch are decisive elements in the positive perception of quality (Restuputri et al., 2021). In this regard, trust emerges as a key component when customers believe in the effectiveness of the service, alleviating fears associated with investing in high-value equipment (Badajoz et al., 2023). Implementing evaluation and monitoring models for post-sale dispatch quality not only increases user satisfaction but also solidifies the image of providers as reliable and committed to excellence (Supriyanto et al., 2021).

The study is based on the Servqual model developed in 1985 by Parasuraman et al., which rigorously measures the constructs of tangibles, reliability, responsiveness, assurance, and empathy, involving the ability to meet expectations for precise and reliable post-sale service as well as optimal responsiveness (Yang et al., 2024). According to Badajoz et al. (2023), high quality in post-sale service significantly increases the likelihood of customers making repeat purchases, as they perceive greater support and trust. Silva et al. (2021) emphasize that good post-sale service encourages customers to return in the long term and to recommend the company to potential clients. Evaluating the quality of post-sale service involves various factors that contribute to a satisfying customer experience. Zambrano (2023) identifies aspects such as effectiveness in problem resolution, efficiency in response times, staff empathy and friendliness, as well as service personalization as key elements that determine customer perception of post-sale service quality.

The Servqual model comprises tangibility, which refers to the physical assets such as infrastructure, equipment, and personnel of the service provider (Hui et al., 2023); complemented by professional attributes and means aligned with attractive services (Setiono & Hidayat, 2022); and visual aspects of the service, such as design and appearance of facilities, equipment, and personnel (Amro et al., 2025; Uzir et al., 2020), fundamental factors for developing quality services (Qing et al., 2023).

Reliability refers to the ability to deliver the promised service under consistent and accurate conditions (Hui et al., 2023). It is also related to the knowledge, courtesy, and capability of personnel to foster trust and alleviate doubts regarding service quality (Setiono & Hidayat, 2022), as well as the ability to provide services as promised, with quality, within the established timeframe, without errors, and aligned with customer service management (Qing et al., 2023). It is associated with the accuracy, consistency, and reliability of the service provided (Amro et al., 2025).

Responsiveness denotes the willingness to promptly assist customers and provide timely service (Hui et al., 2023). It is closely related to the readiness to help customers and deliver services swiftly. Among its attributes is informing customers about the service delivery timeframe (Setiono & Hidayat, 2022). Furthermore, it evaluates the speed and quality with which service providers attend to customers (Amro et al., 2025), indicating determination to provide timely assistance (Qing et al., 2023).

Empathy represents the willingness to care for the customer and personalize their service (Hui et al., 2023). It is linked to the personalized attention provided by the service provider. Its attributes include individualized attention, diligent treatment by employees, prioritization of customer interests, understanding of their needs, and appropriate service hours (Setiono & Hidayat, 2022). It also encompasses the capacity and willingness to understand and attend to customers (Amro et al., 2025), taking care of the customer as a result of service quality (Qing et al., 2023).

Assurance encompasses the capability, respect, and sensibility of personnel to inspire trust (Hui et al., 2023). It also refers to the guarantee and courtesy of employees to generate confidence (Qing et al., 2023). Its attributes include the ability to instill trust in customers during transactions and the courtesy to respond to their inquiries (Setiono & Hidayat, 2022). Consequently, it represents the experience, competence, and credibility that employees must demonstrate regarding the quality of the service offered (Amro et al., 2025).

In this context, customer satisfaction in services is a fundamental concept, referring to the degree to which expectations about a product or service are met or exceeded by the actual experience (Ramírez et al., 2020; Yaranga et al., 2025). This construct is important for the long-term viability of the company, influencing customer loyalty, repurchase behavior, and recommendations to others (Triana & Gómez, 2023; Illa-Sihuincha et al., 2025). Studies indicate that the determining factors of satisfaction are service quality, personalized attention, and efficiency in service delivery, significantly impacting customer commitment and benefits, thus raising satisfaction levels (Quesada, 2021). Moreover, Treviño and Treviño (2021) concluded that the perception of store image and customer experience positively influence satisfaction, highlighting the importance of a coherent and appealing image.

The application of the Servqual model can extend to a wide range of services, generating high levels of satisfaction when quality requirements are met (Qing et al., 2023). It is particularly relevant in emerging markets, where trust in post-sale service becomes a determining factor for the adoption and continuity of advanced agricultural technologies (Zhang et al., 2021; Omar et al., 2021). Therefore, quality in post-sale dispatch in this sector must fulfill commitments for delivery and technical support effectively and reliably, an essential aspect for farmers to maximize the benefits of their investments (Liu et al., 2024). Rigorously measuring this indicator not only allows for the detection of improvement opportunities but also strengthens customer trust, generating a virtuous cycle that enhances the competitiveness of companies in the sector (Hussein Ali et al., 2022).

Based on the above, the study hypotheses are proposed as follows:

H1: Service quality has effects on service trust.
H2: Service quality has effects on staff empathy.
H3: Service quality has effects on service assurance.
H4: Service quality has effects on responsiveness.
H5: Service trust has effects on user satisfaction.
H6: Empathy has effects on user satisfaction.
H7: Service assurance has effects on user satisfaction.
H8: Responsiveness has effects on user satisfaction.

Methodology

The study is framed within a quantitative approach, employing a non-experimental design that is cross-sectional and explanatory in nature. A predictive causal model based on structural equations (SEM) was utilized to analyze the relationships between post-sale service quality and customer satisfaction in the context of agricultural machinery marketing in Lima.

To ensure data representativeness and the objectivity of the selection process, simple random sampling was employed, a technique that gives each element of the population an equal probability of being included in the sample. A total of 673 electronic surveys were distributed via the company's institutional email and managed through the Google Forms platform. The form was available for 30 days, during which 644 responses were received, yielding a gross response rate of 95.7%.

Subsequently, data review and cleansing were conducted to address inconsistencies, blank responses, or duplicate records, resulting in the elimination of 42 observations. Ultimately, a valid dataset of 602 responses was obtained, constituting the final sample for the study. This number exceeds the minimum threshold required for analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM), which necessitates a minimum sample size of 10 cases per model indicator or at least 200 observations when dealing with multiple latent variables (Hair et al., 2021).

Results

The causal model includes five exogenous latent variables (LV) comprising service quality (CAL), trust (CON), empathy (EMP), assurance (SEG), and the endogenous variable user satisfaction (SAT). Table 1 analyzes the validity and reliability of the predictive model, which rigorously presents indicator reliability indices (> 0.50); composite reliability (> 0.50); average variance extracted (AVE > 0.70); and Cronbach's alpha (> 0.70). The values obtained in the analysis present significant parameters that validate the measurement model (Henseler et al., 2015). Thus, it can be confirmed that the indices correlate with the constructs they internally measure.

Table 1
Validity and reliability of the measurement model

Variable	Code	Indicator Reliability	AVE	Composite Reliability	Cronbach's Alpha
Service Quality	CAL	0,854	0,767	0,908	0,848
Responsiveness	CAP	0,846	0,865	0,928	0,843
Trust	CON	0,868	0,746	0,898	0,834
Empathy	EMP	0,893	0,823	0,933	0,892
User Satisfaction	SAT	0,863	0,706	0,905	0,861
Assurance	SEG	0,892	0,752	0,924	0,889

Source. Smart PLS SEM

Table 2 presents the indicators that evaluate the discriminant validity of the measurement model concerning the analyzed constructs, asserting that this must exhibit a higher correlation with respect to other constructs in the model. Accordingly, the values guiding the columns and rows show higher values diagonally than in the consecutive values.

Table 2
Discriminant validity (Fornell-Larcker criterion)

	CAL	CAP	CON	EMP	SAT	SEG
CAL	**(0,876)**					
CAP	0,584	**(0,930)**				
CON	0,545	0,541	**(0,864)**			
EMP	0,542	0,701	0,575	**(0,907)**		
SAT	0,645	0,668	0,685	0,730	**(0,840)**	
SEG	0,588	0,689	0,578	0,752	0,744	**(0,867)**

Source. Smart PLS SEM

Table 3 presents the HTMT validity results as a second validity criterion in the measurement model. The aim is to demonstrate whether significant differences exist between the two analyzed constructs through the value (< 0.85); therefore, sufficient differences exist to conclude that the constructs are distinct from one another, framed within the PLS-SEM structural equation models (Henseler et al., 2015). The values presented meet the criterion.

Table 3
Heterotrait-monotrait ratio (HTMT)

	CAL	CAP	CON	EMP	SAT	SEG
CAL						
CAP	0,685					
CON	0,623	0,639				
EMP	0,621	0,809	0,665			
SAT	0,754	0,776	0,776	0,815		
SEG	0,672	0,793	0,662	0,841	0,833	

Source. Smart PLS SEM

Figure 1 presents the structural model of the study, evaluating causal relationships between the constructs that measure the predictive capacity of the model (Hair et al., 2021). It shows moderate coefficients of determination (R^2) for the latent variables of trust (0.297), empathy (0.294), assurance (0.346), and responsiveness (0.342) as predictors of user satisfaction, with a substantial effect (0.692), indicating that 69.2% of its variance is explained by the model. Additionally, it presents statistically significant path coefficients ($p < 0.01$), and the factor loadings of the indicators are high (> 0.780), suggesting good convergent validity. Therefore, the model demonstrates how service quality directly and indirectly influences user satisfaction through different

dimensions, concluding that there exists predictive quality in the model, robustness in the relationships between variables, relative importance of each construct, and validity of the proposed hypotheses.

Figure 1
Assessment of the structural model

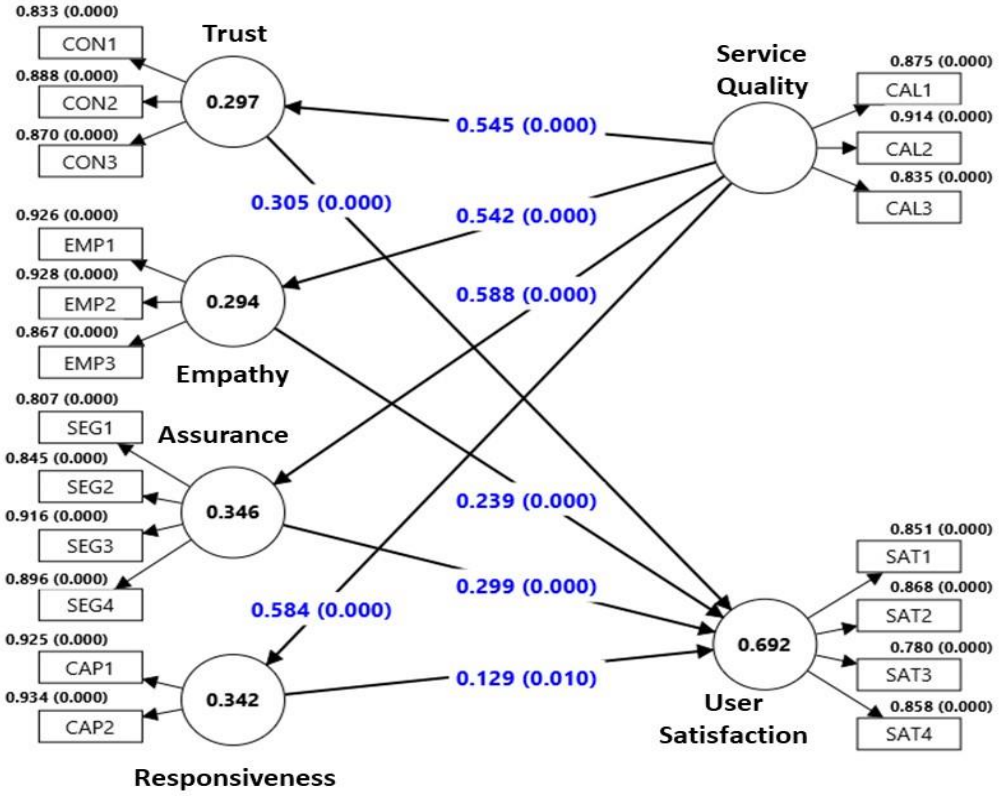


Table 5 shows the results of the hypothesized relationships tested through path coefficients (β) and Bootstrapping analysis, considered significant with values (β ≥ 0.2), allowing us to understand whether the predictor variables contribute to the explained variance of the endogenous variable (Hair et al., 2021). The results present values that significantly support the proposed hypotheses. The predictive model is corroborated, affirming that customer satisfaction is moderately affected by endogenous and exogenous factors.

Table 5
Structural model analysis (Hypothesis testing)

No.	Hypothesis	Correlation	*t Student*	*p Value*	CI [2,5-97.5%]	Result	f^2	CI [2,5-97.5%]
H1	CAL -> CON	0,545	9,317	0,000	[0,427-0,655]	Accepted	0,422	[0,223-0,751]
H2	CAL -> EMP	0,542	8,221	0,004	[0,412-0,668]	Accepted	0,416	[0,205-0,806]
H3	CAL -> SEG	0,588	8,964	0,000	[0,459-0,716]	Accepted	0,529	[0,267-0,049]
H4	CAL -> CAP	0,584	9,368	0,000	[0,463-0,702]	Accepted	0,519	[0,273-0,974]
H5	CON -> SAT	0,305	5,852	0,000	[0,196-0,397]	Accepted	0,183	[0,074-0,332]
H6	EMP -> SAT	0,239	4,287	0,000	[0,128-0,344]	Accepted	0,066	[0,017-0,156]
H7	SEG -> SAT	0,299	6,041	0,000	[0,201-0,395]	Accepted	0,106	[0,043-0,207]
H8	CAP -> SAT	0,129	2,564	0,010	[0,028-0,228]	Accepted	0,024	[0,001-0,080]

Source. Smart PLS SEM

Table 6 presents the model fit using the saturated model and the estimated model with similar values, explaining the probability that the constructs are correlated with each other. Therefore, the theoretically supported model would be equivalent to the connected constructs. Additionally, it shows evidence of model acceptance based on goodness-of-fit criteria, with SRMR (0.08), NFI (0.771), and significant Q^2 for the predictor constructs.

Table 6
Model fit assessment

	Saturated Model	Estimated Model	PLSpredict	Q^2 predict	RMSE	MAE
SRMR	0,080	0,179	Trust	0,280	0,853	0,652
d_ULS	1,202	6,071	Empathy	0,275	0,865	0,558
d_G	0,695	1,019	Assurance	0,325	0,837	0,528
NFI	0,749	0,689	Responsiveness	0,323	0,835	0,523
			User Satisfaction	0,391	0,792	0,559

Source. Smart PLS SEM

Discussion

Regarding H1, the finding supports the notion that efficient, reliable, and professional attention in post-sale service strengthens the customer's perception of integrity and credibility. Hui et al. (2023) highlight that trust is built when customers perceive that the company fulfills its promises and offers precise and transparent technical service. Additionally, Qing et al. (2023) assert that operational quality becomes an emotional component when it reinforces the perception of commitment, fostering sustained business relationships. In the agricultural machinery sector, where the customer relies on technical support for operational continuity, trust is a key differentiating asset.

In relation to H2, this suggests that a well-structured service that adequately responds to technical demands directly influences the customer's perception of the staff's willingness to understand their individual needs. According to Setiono and Hidayat (2022), empathy represents an intangible value that enhances the customer experience, especially in services with high emotional or economic implications. Hui et al. (2023) add that the perception of being treated as a unique customer is a powerful source of satisfaction and differentiation, particularly in contexts where personalized attention is scarce.

Regarding H3, the findings indicate that assurance, understood as the feeling of being in the hands of competent and trustworthy personnel, is particularly relevant in services where errors can have significant operational or economic consequences. Amro et al. (2025) argue that assurance is one of the most valued factors by customers, especially when the service involves technical advice or maintenance. Qing et al. (2023) also emphasize that the accumulated experience of technical staff reinforces trust, generating peace of mind for users and reducing their perception of risk.

With respect to H4, it was evidenced that service quality is a direct antecedent of perceived responsiveness. In other words, the higher the perception of quality, the greater the expectation of receiving prompt and effective attention. According to Yang et al. (2024), responsiveness is not limited to wait times but also includes the efficiency with which problems are resolved. Setiono and Hidayat (2022) note that users especially value the willingness to address emergencies or issues outside established protocols, which is interpreted as an indicator of flexibility and genuine commitment.

In relation to H5, the finding confirms trust's role as a catalyst for consolidating positive experiences. Hui et al. (2023) and Yang et al. (2024) explain that trust acts as a perceptual filter that moderates the customer's tolerance for potential minor failures, reinforcing their predisposition to maintain the business relationship. Moreover, in contexts where the customer cannot technically evaluate the service (as in specialized mechanical support), trust in the honesty and expertise of the provider is crucial for generating sustained satisfaction.

Regarding H6, the result confirms that human treatment and attention to particular needs elevate the customer experience. This result aligns with the literature highlighting the role of emotional capital in service evaluation (Hui et al., 2023; Setiono & Hidayat, 2022). Treviño and Treviño (2021) note that empathy reduces the perception of asymmetry between the company and the customer, generating a collaborative bond that often leads to spontaneous loyalty.

With respect to H7, the result reaffirms that feeling safeguarded and treated by experts contributes to a positive evaluation of the service, especially when the customer must delegate technical problem-solving. Badajoz et al. (2023) assert that in post-sale services, the provider's perception of control increases the sense of certainty and well-being. Furthermore, Supriyanto et al. (2021) explain that assurance becomes a central dimension for satisfaction when the service involves operational or economic risks.

Finally, concerning H8, the result indicates that while speed and efficiency in service are important, their effect is more relevant when complemented by other factors such as empathy and trust. Restuputri et al. (2021) highlight that responsiveness is particularly critical in services where downtime results in economic losses, such

as in the agricultural sector. However, the literature also warns that quick but impersonal attention may not suffice if it is not accompanied by technical quality and an empathetic attitude.

Conclusions

Upon contrasting these results with the theoretical framework, it is evident that post-sale service quality and customer satisfaction are intrinsically linked to customer trust, service assurance, and responsiveness. The reviewed literature supports these findings, emphasizing that efficient management of post-sale service not only satisfies customers but also strengthens their loyalty and trust in the company (Silva et al., 2021). Furthermore, the current research expands existing knowledge by specifying how these factors operate within the agricultural machinery sector, providing empirical evidence that supports the general theory regarding the importance of post-sale service quality in customer satisfaction.

From a practical standpoint, companies operating in similar markets should consider strengthening their post-sale support processes as a key strategy to consolidate customer trust, increase satisfaction, and promote repeat purchases. These results are consistent with recent studies (Yang et al., 2024; Uvet, 2020; Restuputri et al., 2021), which highlight the role of service quality in organizational competitiveness.

However, the study presents limitations associated with its geographical focus (Lima) and sectoral scope (agricultural machinery), which restricts the generalization of its conclusions. Future research could broaden the analytical framework to include other industrial sectors or incorporate moderating variables, such as the type of machinery, the customer's level of technological sophistication, or demographic characteristics. This research provides relevant empirical evidence regarding the influence of post-sale service on customer satisfaction in a key sector for the country's agricultural development, offering a solid basis for designing commercial policies aimed at improving user experience and fostering sustainable business relationships.

In conclusion, the findings of this study reinforce the significance of post-sale service quality and customer satisfaction as key factors for success in the marketing of agricultural machinery. Trust, assurance, and responsiveness emerge as essential elements that not only enhance service quality but also elevate customer satisfaction and loyalty. These results underscore the need for companies to invest in efficient, customer-centered post-sale strategies to ensure lasting relationships and sustainable competitive advantage in the market.

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