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An Integrative Methodological and Conceptual Model of Structural Equation Modeling and Actor-Network Theory for National Logistics Research

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Structural Equation Modeling (SEM); Actor-Network Theory (ANT); mixed methods; joint display matrix; logistics services

Abstract

Modern logistics services operate as complex sociotechnical systems involving service quality, digital technologies, brand perceptions, customer behavior, and interactions among human and nonhuman actors. However, existing studies often examine these dimensions separately and apply methodological approaches that cannot simultaneously quantify structural relationships and explain their underlying mechanisms. This study aimed to develop an integrative conceptual model combining Structural Equation Modeling (SEM) and Actor-Network Theory (ANT) for logistics research. A conceptual model development approach based on a Systematic Literature Review (SLR) was employed. The process involved identifying logistics phenomena and methodological gaps, mapping relevant theories and constructs, conducting multidimensional synthesis, defining the respective functions of SEM and ANT, and establishing convergence through a parallel mixed-methods design and joint display matrix. The findings resulted in a framework integrating 17 constructs derived from SERVQUAL, Logistics Service Quality, information and communication technology, expectation-based brand equity, Voice of the Customer, and customer relationship management. SEM quantified direct and indirect relationships among constructs, whereas ANT traced human and nonhuman networks that generated, stabilized, or disrupted service outcomes. The integration of these approaches supported convergent, complementary, and divergent interpretations for identifying Key Success Factors (KSFs) and determining managerial priorities. The proposed framework provides a comprehensive foundation for evaluating logistics services; however, empirical validation across different providers, regions, and service types is required to confirm its applicability and robustness.

INTRODUCTION

The evolution of modern logistics has transformed logistics services from simple physical freight movement into complex sociotechnical service systems that integrate flows of goods, information, technology, organizational processes, and customer interactions within interconnected service networks. The rapid growth of e-commerce and financial technology (fintech), driven by transaction digitalization, has increased customer expectations regarding speed, transparency, security, and digital service reliability. On the one hand, service quality continues to be influenced by established dimensions, such as those defined in Service Quality (SERVQUAL) and Logistics Service Quality (LSQ). On the other hand, service quality is increasingly shaped by information technology capabilities and customer brand trust, which together support long-term relationships between customers and service providers. This

complexity is further intensified because logistics services are constructed not only through human actors, such as customers and couriers, but also through various nonhuman elements, including mobile applications, transportation fleets, brand identity, tracking systems, digital platforms, technological infrastructure, distribution networks, regulations, and physical parcels. Therefore, modern logistics services should be conceptualized as both multidimensional phenomena and sociotechnical networks, requiring analytical frameworks capable of explaining structural relationships among factors as well as the network dynamics that shape these relationships.

This complexity is particularly evident in Indonesia amid rapid digital economic growth. Indonesia's logistics and supply chain market is projected to reach USD 131.20 billion in 2025 and increase to USD 188.38 billion by 2031, representing a compound annual growth rate (CAGR) of approximately 6.21%, primarily driven by increasing e-commerce activities and national infrastructure development (Nexdigm, 2025; Mordor Intelligence, 2026). This transformation has been accompanied by increasing consumer demands for faster operations, shipment tracking transparency, and digital accessibility. Differences in organizational capability to adapt to this environment can be observed through the Top Brand Index performance of J&T Express, a private national courier company, and Pos Indonesia, the state-owned logistics enterprise. Between 2023 and 2026, J&T Express's brand index increased from 33.30% to 46.89%, whereas Pos Indonesia's index declined from 7.30% to 5.29% during the same period. Previous empirical studies have identified several operational challenges faced by Pos Indonesia, including inaccurate shipment information, delivery delays, and inconsistencies in parcel handling (Hersanto et al., 2023; Evant et al., 2023; Yanuar & Bisma, 2025).

However, this complexity has not yet been comprehensively addressed within a single logistics service theoretical framework. SERVQUAL provides a foundational approach for evaluating interpersonal service quality through dimensions of tangibility, reliability, responsiveness, assurance, and empathy (Parasuraman et al., 1988), whereas Logistics Service Quality (LSQ) provides a more specialized operational perspective by emphasizing dimensions such as order timeliness, order accuracy, and order condition (Mentzer et al., 2001). Nevertheless, the increasing digitalization of logistics requires the incorporation of emerging digital dimensions, including digital information quality, online procedures, and e-commerce platform integration. At the same time, customer decision-making is influenced by cognitive brand dimensions, such as brand awareness, brand trust, and brand image, which subsequently affect purchase decisions, customer satisfaction, and loyalty. Existing literature indicates that physical service quality, operational performance, digital technology capabilities, brand perceptions, and customer relationship dynamics are frequently examined separately, resulting in a fragmented understanding of how these interconnected dimensions collectively function within modern logistics ecosystems.

Previous logistics studies have largely relied on linear regression, gap analysis, Importance–Performance Analysis (IPA), or separate applications of SERVQUAL and LSQ, thereby examining relationships among variables in a fragmented manner. These conventional approaches have limitations in explaining complex logistics phenomena. Structural Equation Modeling (SEM) is effective for examining direct and indirect relationships among latent constructs and evaluating theoretical model fit using empirical data (Byrne, 2016; Kline, 2016). SEM can identify statistically significant factors, relationship directions, and effect magnitudes.

In contrast, Actor-Network Theory (ANT) examines how human and nonhuman actors form networks through processes of translation and association (Callon, 1986; Law, 1992; Latour, 2005), although it is not designed to quantify causal path coefficients. This methodological distinction reveals an important research limitation: SEM provides strong quantitative explanations of structural relationships by determining which factors influence outcomes and the magnitude of those influences, but it provides limited insight into how and why these relationships emerge within sociomaterial contexts. Conversely, ANT provides rich qualitative explanations of relational network mechanisms but lacks the ability to measure statistical effect strength. Therefore, an integrative methodological framework is needed to simultaneously quantify structural relationships and explain the sociotechnical mechanisms underlying complex logistics operations. Existing literature further indicates that logistics research remains predominantly oriented toward quantitative approaches, often overlooking interactions between human and nonhuman actors as fundamental mechanisms influencing service success or failure.

This article aimed to formulate an integrative theoretical, conceptual, and methodological model combining Structural Equation Modeling (SEM) and Actor-Network Theory (ANT) as a multidimensional framework for analyzing national logistics services and generating deeper empirical and conceptual insights. By integrating both methodologies within a coherent convergent design, the proposed framework provides an analytical perspective that addresses not only which factors influence logistics performance and the magnitude of their effects, but also how, why, and through which actor-network configurations these influences occur. The proposed model serves as a conceptual foundation for future empirical investigations seeking to examine sociotechnical complexity and identify key determinants of logistics service performance in Indonesia.

METHOD

This study employed a conceptual model development approach based on a Systematic Literature Review (SLR) to establish an integrative theoretical and methodological framework combining Structural Equation Modeling (SEM) and Actor-Network Theory (ANT) in logistics service research. The analysis focused on foundational theories, key constructs, relationships among constructs, methodological gaps, and the complementary roles of both analytical approaches. The model formulation was conducted through several stages: (1) identifying logistics phenomena, (2) examining methodological gaps, (3) mapping theoretical foundations and constructs, (4) conducting multidimensional synthesis, (5) defining the analytical roles of SEM and ANT, and (6) establishing integration points between the two approaches.

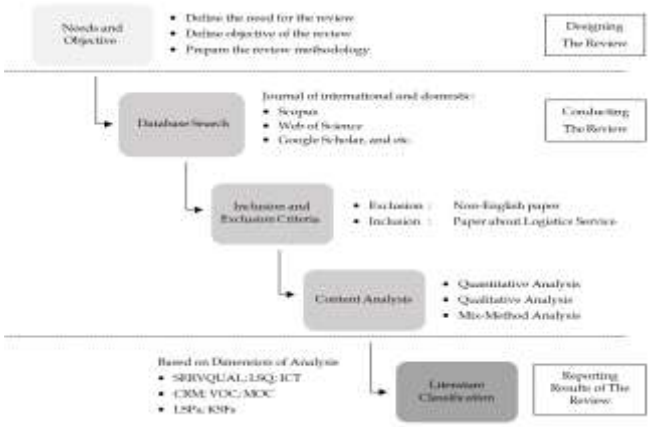

Figure 1. Systematic Literature Review (SLR) Workflow for Conceptual Model Development

Systematic Literature Review

The conceptual framework was developed using a three-stage Systematic Literature Review (SLR) protocol.

Stage 1. Designing the Review

Establishing the research scope based on logistics service complexity, theoretical gaps, and methodological limitations in existing literature.

Stage 2. Conducting the Review

Comprehensive searching across national and international scholarly databases, followed by screening and content analysis of quantitative, qualitative, and mixed-methods publications. *Inclusion Criteria:* Peer-reviewed journal articles, academic books, and theoretical treatises addressing service quality, customer satisfaction, and loyalty within logistics, courier services, freight transport, third-party logistics (3PL), service technology, and customer experience, published in English or Indonesian. Recent empirical literature was prioritized to capture current industry dynamics, while seminal works were utilized for foundational theoretical anchoring. *Exclusion Criteria:* Publications lacking substantive relevance to the core domains; works failing to provide theoretical definitions, structural relationships, synthesizable empirical findings, or clear methodological details; non-English/non-Indonesian publications; and duplicate entries.

Stage 3: Reporting the Results

Classifying reviewed literature across theoretical domains and methodological traditions to construct theoretical mapping, methodological mapping, and gap identification matrices. These synthesized insights serve as the foundational architecture connecting service dimensions, digital technologies, customer evaluations, and socio-technical networks into an integrative SEM–ANT framework.

Philosophical Resolution of Epistemological Integration

Integrating SEM and ANT brings together two distinct epistemological paradigms. SEM is situated within a positivist/postpositivist paradigm, representing service phenomena through latent constructs, observable indicators, and empirically testable structural paths. In contrast, ANT operates from a relational-empirical and socio-material constructivist perspective, conceptualizing service quality as an emergent, transient outcome of heterogeneous networks comprising human and non-human actors governed by translation and association processes.

Rather than resolving this divergence by conflating their ontological assumptions, the framework preserves their distinct epistemic integrity to examine logistics phenomena from complementary analytical angles.

RESULTS AND DISCUSSIONS

The findings of this conceptual study present a theoretical and methodological synthesis that establishes an integrated theoretical measurement structure alongside a two-tier analytical framework for logistics services. Theoretically, this research expands the dimensional factor structure utilized to evaluate logistics service performance. Methodologically, it advances a novel mixed-methods design coupling Structural Equation Modeling and Actor-Network Theory (SEM–ANT). The SEM strand models structural relationships among service quality, operational performance, digital technology, brand expectations, usage decisions, customer satisfaction, and loyalty. Concurrently, the ANT strand unpacks the relational network mechanisms constituting service delivery through dynamic interactions among human and non-human actors. Integrating both paradigms enables researchers to simultaneously identify statistically significant structural determinants and trace the underlying socio-technical processes governing service success and continuous improvement. This conceptual foundation synthesizes key frameworks drawn from seminal literature: Service Quality (SERVQUAL), Logistics Service Quality (LSQ), Information and Communication Technology (ICT), Expectation Brand Equity (EBE), Expectation Confirmation Theory (ECT), Customer Relationship Management (CRM), and Voice of the Customer (VOC).

Conceptual Approach

The conceptual approach is structured through a dual architecture established via the Systematic Literature Review (SLR): a theoretical synthesis and a methodological conceptual framework. The theoretical synthesis integrates SERVQUAL, LSQ, ICT, EBE, ECT, CRM, and VOC into a unified multidimensional framework for logistics services. The methodological conceptual framework operationalizes an integrative SEM–ANT mixed-methods design.

Theoretical Synthesis

Brand Equity Theory (Aaker, 1991; Keller, 1993), which underpins Expectation Brand Equity (EBE), posits that brand awareness and brand image—reinforced by brand trust (Chaudhuri & Holbrook, 2001)—act as cognitive perceptual stimuli influencing customer purchase decisions. Within digitalized service ecosystems, integrating Information and Communication Technology (ICT) dimensions—specifically e-commerce integration, online procedures, and digital information—plays a pivotal role in driving purchase decisions and shaping customer satisfaction, aligning with information systems success and technology acceptance models (Davis, 1989; DeLone & McLean, 2003). On the physical operational front, Logistics Service Quality (LSQ) (Mentzer et al., 2001) demonstrates that realized performance in order condition, order accuracy, and order timeliness constitutes a primary determinant of customer satisfaction, functioning synergistically with the five classic SERVQUAL dimensions (Parasuraman et al., 1988): empathy, assurance, responsiveness, reliability, and tangible.

Expectation Confirmation Theory (Oliver, 1980) bridges the customer satisfaction formation process through post-purchase evaluations when realized service performance meets or exceeds the initial expectations underlying the purchase decision. Furthermore, Relationship Marketing Theory (Morgan & Hunt, 1994) and Customer Loyalty Theory (Oliver, 1999) assert

that responsive relationship governance, proactive integration of customer feedback, and elevated satisfaction levels collectively foster long-term customer loyalty, with positive purchase experiences reinforcing customer retention and sustained behavioral commitment. Finally, the Voice of the Customer (VOC) framework (Akao, 1990; Griffin & Hauser, 1993) broadens service evaluation by capturing multifaceted customer perspectives across five key domains: Customer Expectation as the expectations held by the customer prior to using the service; Actual Experience as the real-life experience during the service process; Customer Perceived as the customer's assessment of service quality; Complaints and Discrepancies as complaints and the gap between expectations and experience; and Feedback and Innovations as customer input and potential service improvements.

Methodological Conceptual Framework

The SEM–ANT mixed-methods framework integrates quantitative structural modeling across multifaceted logistics dimensions with qualitative explorations of socio-technical dynamics and customer experiences. SEM is employed to simultaneously model and test direct and indirect structural relationships among latent constructs (Byrne, 2016; Kline, 2016). This provides rigorous empirical evidence regarding construct validity, path coefficients, and comparative service performance differentials. Measurement models confirm that observed indicators reliably represent theorized latent constructs, while structural models test hypothesized linkages among service quality dimensions, information technology, marketing orientations, purchase decisions, customer satisfaction, and customer loyalty. Conversely, ANT traces heterogeneous interactions among human and non-human actors through translation and network stabilization processes (Callon, 1986; Law, 1992; Latour, 2005). The ANT lens elucidates the underlying rationales, mechanisms, and contextual contingencies that forge service configurations—uncovering the socio-technical networks that generate competitive advantages or operational breakdowns. Consequently, SEM delineates the structural architecture of influence (*what* and *how much*) and ANT reveals the relational socio-technical networks that construct and sustain that architecture within logistics services (*how* and *why*).

Table 1. Theoretical Domains and Research Variable Constructs

Dimensi	Konstruk	Sumber
SERVQUAL	Tangible	• Parasuraman et al. (1988) • Zeithaml et al. (1990) • Cronin & Taylor (1992) • Buttle (1996) • Brady & Cronin (2001) • Ladhari (2009)
	Reliability	
	Responsiveness	
	Assurance	
	Empathy	
LSQ	Order Timeless	• Bienstock et al. (1997) • Mentzer et al. (1999 & 2001) • Stank et al. (2003) • Rafele (2004) • Thai (2013)
	Order Accuracy	
	Order Condition	
Dimensi	**Konstruk**	**Sumber**
ICT	Digital Information	• Zhu et al. (2006) • Sanders (2016) • Gunasekaran et al. (2017) • Turban et al. (2018) • Laudon & Laudon (2022)
	Online Procedure	
	E-Commerce Integration	

EBE / MOC (Terminologi MOC/ Mind of Customer diganti Expectetion Brand Equity/ EBE)	Brand Awareness	• Aaker (1991 & 1996) • Percy & Rossiter (1992) • Keller (1993 & 2008) • Morgan & Hunt (1994) • Chaudhuri & Holbrook (2001) • Delgado-Ballester (2004) • Delgado-Ballester & Munuera-Alemán (2005) • Kotler & Keller (2016)
	Brand Trust	
	Brand Image	
VOC	Customer Expectation	• Akao (1990) • Griffin & Hauser (1993) • Mahavarpour et al. (2023) • Gahler et al. (2023) • Franco & Meneses (2024) • Hassan (2024) • Zhang & Huang (2025) • Ballandies et al. (2025) • Gao et al. (2026)
	Actual Experience	
	Customer Perceived	
	Complaints & Discrepancies	
	Feedback & Inventions	
CRM	Purchase Decision	• Oliver (1980 & 1999) • Dick & Basu (1994) • Morgan & Hunt (1994) • Verhoef (2003) • Payne & Frow (2005) • Kotler & Keller (2016) • Buttle & Maklan (2019)
	Satisfaction	
	Loyalty	

Creating an Integrative Theoretical Framework

Table 3 illustrates the theoretical domain framework operationalized within the SEM and ANT approaches. The integrative linkage is established by positioning SEM constructs as structural representations of variable domains that delineate logistics service phenomena to identify critical service determinants. Concurrently, ANT serves as a relational lens that traces how these structural service domains are actualized, negotiated, stabilized, or undermined across networks of heterogeneous human and non-human actors.

SEM Conceptual Mapping: Hypotheses Development

The proposed SEM architecture comprises 14 exogenous constructs and three core endogenous customer behavioral constructs situated within the CRM domain: purchase decision, customer satisfaction, and customer loyalty. The exogenous constructs originate from four foundational domains: SERVQUAL, LSQ, ICT, and EBE (as detailed in Table 3). This configuration yields 20 structural paths representing the antecedents of customer adoption decisions, satisfaction, and long-term brand loyalty. The hypotheses are formalized as follows:

Hypothesis 1. Brand Awareness and Purchase Decision

According to Aaker (1991), higher levels of consumer brand awareness substantially increase the probability of brand selection. Empirical findings by Hakim & Keni (2020) and Suardana et al. (2024) confirm that brand awareness exerts a positive and significant influence on purchase intention. Therefore, it is hypothesized:

H1: *Brand awareness has a positive and significant effect on purchase decisions among logistics service users.*

Hypothesis 2. Brand Trust and Purchase Decision

Chaudhuri & Holbrook (2001) posit that greater consumer trust in a brand elevates the propensity to purchase its offerings. Studies by Priscilla (2020) and Benhardy et al. (2020)

demonstrates that brand trust significantly drives purchase decisions. Therefore, it is hypothesized:

H2: *Brand trust has a positive and significant effect on purchase decisions among logistics service users.*

Hypothesis 3. Brand Image and Purchase Decision

Keller (1993) asserts that a favorable brand image establishes perceptions of superior quality, credibility, and overall value, reinforcing consumer purchase confidence. Empirical evidence from Priscilla (2020) and Suardana et al. (2024) validate that brand image positively and significantly influences purchase choices. Therefore, it is hypothesized:

H3: *Brand image has a positive and significant effect on purchase decisions among logistics service users.*

Hypothesis 4. E-Commerce Integration and Purchase Decision

Drawing from the Technology–Organization–Environment (TOE) framework (Tornatzky & Fleischer, 1990), inter-organizational IT integration facilitates rapid, accurate, and seamless information exchange, enhancing operational efficiency. Al-Debei et al. (2015) and Purwanto et al. (2023) show that digital integration positively influences purchasing decisions. Therefore, it is hypothesized:

H4: *E-commerce integration has a positive and significant effect on purchase decisions among logistics service users.*

Hypothesis 5. Online Procedure and Purchase Decision

Under the Technology Acceptance Model (TAM; Davis, 1989), perceived ease of use is a critical driver of technology adoption. Research by Rita et al. (2019) and Khoa et al. (2020) demonstrates that streamlined, intuitive online transaction procedures significantly stimulate platform purchase decisions by elevating user convenience. Therefore, it is hypothesized:

H5: *Online procedure has a positive and significant effect on purchase decisions among logistics service users.*

Hypothesis 6. Digital Information and Purchase Decision

DeLone & McLean (2003) emphasize that information quality is vital to information system success. High-quality digital information—characterized by accuracy, completeness, relevance, and clarity—mitigates consumer ambiguity during digital evaluations (Akram et al., 2021; Khoa et al., 2020). Therefore, it is hypothesized:

H6: *Digital information has a positive and significant effect on purchase decisions among logistics service users.*

Hypothesis 7. E-Commerce Integration and Customer Satisfaction

DeLone & McLean (2003) note that effective systems integration ensures continuous, real-time information flows across operational touchpoints, enhancing overall service quality. Rita et al. (2019) and Purwanto et al. (2023) indicate that integrated electronic service capabilities directly bolster user satisfaction. Therefore, it is hypothesized:

H7: *E-commerce integration has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 8. Online Procedure and Customer Satisfaction

Perceived ease of operational procedures directly shapes user satisfaction during technological interactions (Davis, 1989). Empirical findings by Khoa et al. (2020) and Rita et al. (2019)

confirm that effortless electronic navigation and execution are primary determinants of customer satisfaction. Therefore, it is hypothesized:

H8: *Online procedure has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 9. Digital Information and Customer Satisfaction

In line with the DeLone & McLean (2003) IS Success Model, information quality directly governs user satisfaction. Studies by Mukhopadhyay et al. (2024), Akram et al., (2021), and Khoa et al. (2020) demonstrate that accurate and accessible digital tracking data significantly enhances satisfaction. Therefore, it is hypothesized:

H9: *Digital information has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 10. Order Condition and Customer Satisfaction

Mentzer et al. (2001) define order condition as a core pillar of Logistics Service Quality (LSQ). Ramanathan (2018) and Vakulenko et al. (2019) confirm that a logistics provider's ability to prevent parcel damage during transit significantly enhances the customer service experience and satisfaction. Therefore, it is hypothesized:

H10: *Order condition has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 11. Order Accuracy and Customer Satisfaction

Order fulfillment precision serves as a foundational operational benchmark in logistics delivery (Mentzer et al., 2001). Investigations by Buldeo Rai et al. (2019) and Nguyen et al. (2022) verify that order accuracy significantly minimizes customer frustration and drives satisfaction. Therefore, it is hypothesized:

H11: *Order accuracy has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 12. Order Timeliness and Customer Satisfaction

Delivery punctuality represents an essential dimension of logistical competence (Mentzer et al., 2001). Prior studies (Murfield et al., 2017; Vakulenko et al., 2019) indicate that meeting promised delivery windows significantly reinforces overall customer satisfaction. Therefore, it is hypothesized:

H12: *Order timeliness has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 13. Empathy and Customer Satisfaction

Parasuraman et al. (1988) define empathy as personalized attention and genuine care provided to consumers. Research by Uzir et al. (2021) and Nguyen et al. (2022) indicates that empathetic interpersonal service interactions directly increase customer satisfaction. Therefore, it is hypothesized:

H13: *Empathy has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 14. Assurance and Customer Satisfaction

Assurance encompasses the security of consignments, institutional credibility, and employee professionalism, which collectively attenuate perceived transaction risk (Parasuraman et al., 1988). Ali et al. (2021) and Dam & Dam (2021) confirm that service assurance significantly strengthens satisfaction. Therefore, it is hypothesized:

H14: *Assurance has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 15. Responsiveness and Customer Satisfaction

Responsiveness reflects organizational speed and willingness in providing shipment updates, confirming orders, and resolving complaints (Parasuraman et al., 1988). Uzir et al. (2021) and Nguyen et al. (2022) demonstrate that prompt service responses positively enhance customer evaluations. Therefore, it is hypothesized:

H15: *Responsiveness has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 16. Reliability and Customer Satisfaction

Reliability denotes the capability to deliver agreed services dependably and accurately (Parasuraman et al., 1988). Dam & Dam (2021) and Nguyen et al. (2022) confirm that operational reliability is a paramount driver of service satisfaction. Therefore, it is hypothesized:

H16: *Reliability has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 17. Tangible and Customer Satisfaction

Tangible encompass the physical manifestations of service delivery, such as delivery fleets, uniforms, facilities, and physical branch infrastructure (Parasuraman et al., 1988). Research by Ali et al. (2021) and Uzir et al. (2021) confirms that tangible assets significantly influence overall customer satisfaction. Therefore, it is hypothesized:

H17: *Tangible has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 18. Purchase Decision and Customer Satisfaction

Grounding this relationship in Expectation Confirmation Theory (Oliver, 1980), customer satisfaction emerges through post-purchase evaluations when lived service experiences validate or surpass initial expectations. Studies by Dam & Dam (2021) and Ali et al. (2021) demonstrate that favorable purchase decisions based on high service quality perceptions positively drive customer satisfaction. Therefore, it is hypothesized:

H18: *Purchase decision has a positive and significant effect on customer satisfaction among logistics service users.*

Hypothesis 19. Purchase Decision and Customer Loyalty

According to Kotler & Keller (2016), purchase decisions yielding positive service encounters significantly heighten the likelihood of repeat engagement. Konuk (2019) and Nguyen et al. (2022) confirm that consumers driven by positive service evaluations exhibit stronger behavioral intentions to sustain brand patronage. Therefore, it is hypothesized:

H19: *Purchase decision has a positive and significant effect on customer loyalty among logistics service users.*

Hypothesis 20. Customer Satisfaction and Customer Loyalty

Oliver (1999) establishes that customer satisfaction represents a cumulative post-consumption evaluative state, whereas customer loyalty reflects a deeply held behavioral and attitudinal commitment to repurchase preferred services consistently. Studies by Uzir et al. (2021) and Nguyen et al. (2022) substantiate that customer satisfaction is the primary antecedent of long-term loyalty. Therefore, it is hypothesized:

H20: *Customer satisfaction has a positive and significant effect on customer loyalty among logistics service users.*

Structural Summary of Model Hypotheses

Structurally, brand awareness (H1), brand trust (H2), brand image (H3), e-commerce integration (H4), online procedure (H5), and digital information (H6) are modeled as direct antecedents to purchase decision. Concurrently, e-commerce integration (H7), online procedure (H8), digital information (H9), order condition (H10), order accuracy (H11), order timeliness (H12), empathy (H13), assurance (H14), responsiveness (H15), reliability (H16), and tangible (H17) are positioned as direct predictors of customer satisfaction. Finally, purchase decision directly predicts customer satisfaction (H18) and customer loyalty (H19), while customer satisfaction serves as the direct structural antecedent to customer loyalty (H20).

ANT Conceptual Mapping: Exploratory Extension

The qualitative exploratory extension in this framework positions customer expectation and actual experience as baseline exogenous domains that serve as the point of departure for understanding how customer evaluations are forged in national logistics services. Customer expectation encompasses initial anticipations regarding delivery timeliness, consignment safety, informational accuracy, procedural ease, and service responsiveness, whereas actual experience reflects lived customer encounters during service delivery. These two domains are subsequently explored in relation to three endogenous analytical categories: customer perceived quality, complaints and discrepancies, and feedback and innovations. Customer perceived quality captures subjective evaluative assessments of delivered service quality; complaints and discrepancies delineate grievances and structural mismatches between expectations and actual service delivery; and feedback and innovations illustrate how customer feedback acts as a catalyst for service remediation and system innovation. Within the qualitative ANT tradition, these constructs serve as analytical categories to unpack lived experiences, subjective meanings, relational dynamics, and service improvement trajectories in depth.

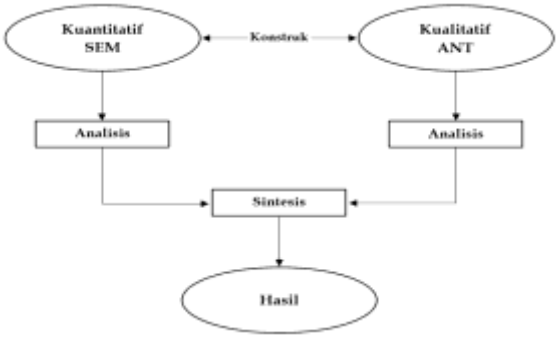

Figure 2. Complementarity–Convergent Parallel Mixed Methods Design

Architecture of the Integrative Conceptual Model

The methodological architecture adopts a Convergent Parallel Mixed Methods Design (Creswell & Plano Clark, 2018), fortified by the principle of Complementarity (Greene et al., 1989), through an integrative SEM–ANT framework. This model coordinates two analytical lenses across three operational tiers (Figure 2): *Structural Explanation* in the statistical modeling stage via SEM (Figure 3); *Relational Explanation* in the explanatory qualitative stage via ANT (Figure 4); and *Integrative Explanation* in the Joint Display Matrix through the

systematic juxtaposition of both strands. Rather than conflating the philosophical divergences between SEM and ANT, this architecture orchestrates two distinct modes of inquiry to provide a more comprehensive account of logistics service complexity.

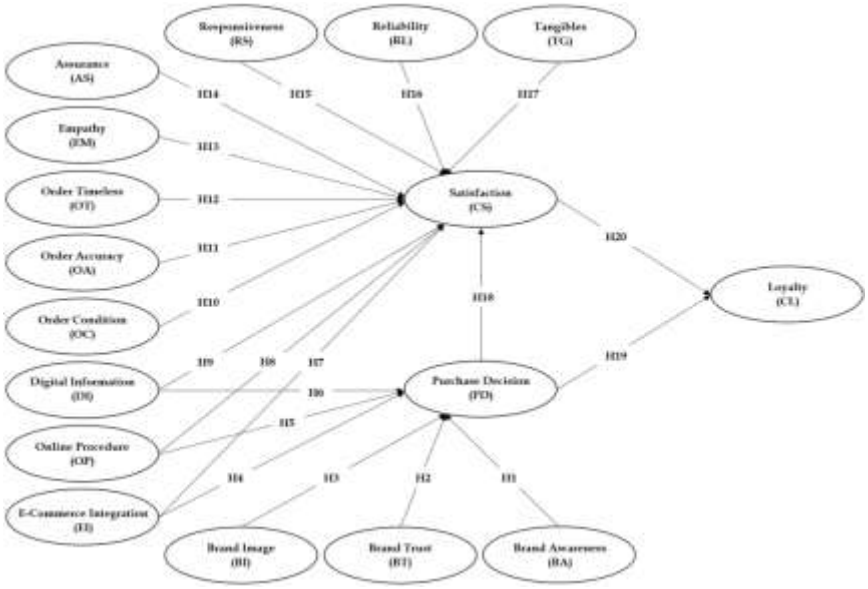

Figure 3. Conceptual Structural Model for SEM Analysis

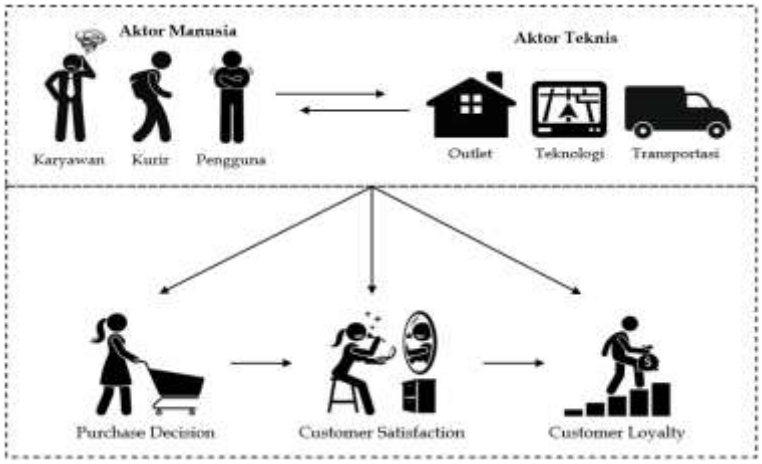

Figure 4. Conceptual Relational Network Model for ANT Analysis

Methodological Operational Workflow

Constructs within SEM factors and actants within ANT networks do not exhibit a one-to-one correspondence. A single SEM construct can be enacted and produced by multiple heterogeneous actors, while a single actor can participate across multiple structural constructs. For instance, an automated *tracking system* operates across reliability, digital information, online procedure, order timeliness, and brand trust. Conversely, a macro construct such as *customer satisfaction* lacks a single dedicated technical actor, as it is the emergent outcome of whole-network configuration. Consequently, the integration between the two paradigms must be conceptualized as a structure–network layer interplay rather than a direct variable-to-code conversion. The operational workflow proceeds through the following sequential stages:

Stage 1: Parallel Data Collection

Quantitative and qualitative data are collected concurrently across identical logistics service phenomena, utilizing distinct instruments tailored to the analytical functions of SEM and ANT:

A. Quantitative Strand – SEM

1. *Instrument Development:* SEM constructs are operationalized into 52 survey indicators (Table 4).
2. *Perceptual Measurement:* Indicators are evaluated using 5-point or 7-point Likert scales ranging from 1 (*strongly disagree*) to 5/7 (*strongly agree*), where higher scores indicate more positive evaluations.
3. *Survey Administration:* Questionnaires are distributed to targeted logistics service users based on predefined sampling criteria.
4. *Pilot Testing:* An initial sample of 30 respondents is collected to assess preliminary validity and reliability in SPSS.
5. *Screening and Tabulation:* Responses undergo screening for completeness and criteria adherence, followed by numerical tabulation for covariance-based SEM (CB-SEM via AMOS) or partial least squares SEM (PLS-SEM via SmartPLS).

Table 2. Operational Indicators of SEM Latent Constructs

Dimension	**Construct**	**Indicator**
SERVQUAL	Tangibles	Physical facilities of the logistics company appear clean, modern, and well-maintained.
		The appearance of logistics company personnel is neat, polite, and professional.
		The digital system (website/application) is easy to use and has a professional interface.
		Vehicles and operational equipment are in good condition and suitable for use.
	Reliability	The company has reliable and professional service standards and employees.
		The company provides consistent services every time I use its services.
		Shipment status information provided by the company is accurate and trustworthy.
		The company has a logistics system that minimizes the risk of damage.
	Responsiveness	Service personnel respond quickly to customer inquiries.
		Personnel provide immediate assistance when problems occur during the delivery process.
		Customer complaints are handled quickly and satisfactorily.
		The company provides timely information regarding the delivery process.
	Assurance	Personnel have adequate knowledge to answer customer questions.
		Personnel act politely and professionally when providing services.
		The company ensures the security of goods during distribution and delivery processes.

		The company provides compensation or protection guarantees in case of service errors.
	Empathy	The company understands customer needs accurately and appropriately.
		Personnel provide personal attention to customers when needed.
		The company provides easy access to assistance and information for customers.
		The company provides appropriate solutions when customers experience problems.
LSQ	Order Timeless	The company delivers goods according to the promised delivery time.
		The estimated delivery time provided corresponds with the actual arrival time of goods.
		The company is able to minimize delays in the delivery process.
		Goods are received according to the expected delivery schedule.
	Order Accuracy	Goods that I send or receive arrive at the destination correctly.
		The quantity of goods matches the initial condition without delivery errors.
		The delivery destination matches the specified address
		Shipment information provided corresponds with actual conditions.
	Order Condition	Goods are received in good condition without damage
		Product packaging remains intact throughout the delivery process.
		The quantity of goods I send or receive matches the expected amount upon arrival.
		Personnel provide additional protection for shipped goods.
ICT	Digital Information	Information regarding rates, services, delivery procedures, and estimated delivery times is available completely through digital media, such as websites or applications.
		The company provides real-time shipment status information that customers can easily access through websites/applications.
		The company's logistics service information on its website/application is regularly updated according to actual conditions.
		The company's digital system (website/application) enables customers to obtain required information anytime.
	Online Procedure	I can easily order logistics/courier services online.
		Payment processes can be conducted securely and conveniently online.
		Shipment tracking processes can be conducted online without difficulty.
		Complaints or inquiries can be submitted through the company's online systems, such as websites, applications, or WhatsApp messaging services.

	E-Commerce Integration	The logistics service system is integrated with the e-commerce platform I use. Logistics service information on e-commerce platforms can be processed automatically. Shipment status on e-commerce platforms is automatically updated by the logistics company. Integration between logistics companies and e-commerce platforms facilitates delivery processes and order processing.
MOC	Brand Awareness	I am aware of this logistics service brand. I know the various services offered by this logistics company. This logistics company is one of the first brands I recall when I need delivery services. I can easily recognize and distinguish this logistics company's brand from other logistics companies.
	Brand Trust	I believe this logistics company has qualified and reliable employees. I trust that this logistics company provides services according to its promises. I believe this company has professional services and well-established and tested standard operating procedures (SOPs). I believe this logistics company can be relied upon in every service and delivery process.
	Brand Image	The company has a professional image in customers' perceptions. The company is recognized as a provider of high-quality logistics services. The company has a good reputation compared with other logistics companies. In my opinion, the company can be relied upon in providing services.

Table 3 Qualitative Interview Protocol Framework for ANT Exploration

Section	Framework	Objective
1	User Identity and Background	Understanding customer profiles and their usage of logistics services.
2	Customer Expectations Toward Logistics Services	Identifying the ideal expectations of logistics service users.
3	Actual Service Usage Experience	Evaluating users' real experiences with the provided services
4	GAP Analysis Between Expectations and Experiences	Identifying gaps between service expectations and actual service performance.
5	Benchmarking: Comparison Among Service Providers Benchmarking:	Obtaining direct comparative insights from customers.

6	Customer Recommendations	Exploring suggestions for improving logistics services.
7	Introspection	Clarifying key points and providing opportunities for reflection.

B. Qualitative Strand – ANT

1. *Interview Protocol Design:* A semi-structured interview protocol with open-ended probes is developed across logistics service quality categories.
2. *Informant Selection:* Key informants representing varied customer profiles are selected and interviewed face-to-face or online.
3. *Experiential Exploration:* Interviews traverse seven analytical domains (Table 5): user identity, expectations, actual experiences, service gaps, benchmarking, recommendations, and reflective evaluations.
4. *Actor Tracing:* In-depth narratives trace human and non-human actors co-constituting the logistics delivery ecosystem.
5. *Phenomenological Equivalence:* Both strands achieve empirical alignment by observing congruent real-world touchpoints (Table 6). For instance, quantitative metrics of *order timeliness* are enriched by narrative accounts of delivery workflows, while *digital information* metrics are complemented by tracing how shipment status data is generated, updated, transmitted, and consumed.

Stage 2: Independent Data Analysis

Following parallel data collection, quantitative and qualitative datasets are analyzed independently to safeguard the paradigm-specific analytical logic of each method prior to integration:

A. Quantitative Strand – SEM

1. *Instrument Validation:* Pilot data ($N = 30$) is evaluated in SPSS, requiring Pearson correlation coefficients > 0.50 for construct validity and Cronbach's alpha > 0.70 for internal consistency (Ghozali, 2009).
2. *Measurement Model Evaluation:* Assessed via AMOS (CB-SEM) or SmartPLS (PLS-SEM) by establishing Construct Reliability (CR > 0.70) and Average Variance Extracted (AVE > 0.50) (Hair et al., 2019).
3. *Goodness-of-Fit Assessment:* Model fit is evaluated using a combination of 3–5 absolute and incremental fit indices (Hair et al., 2019).
4. *Assumption Checking:* Multivariate normality and outlier presence are assessed, identifying multivariate outliers via Mahalanobis distance (D^2).
5. *Structural Model Testing:* Hypothesized structural paths are evaluated to estimate path directionality, standardized coefficients (β), and statistical significance (p-values) to isolate primary structural determinants.
6. *Analytical Alternatives:* CB-SEM via AMOS serves as the primary analytical framework, with PLS-SEM via SmartPLS positioned as an alternative depending on distributional properties and research objectives.

B. Qualitative Strand – ANT

1. *Transcription:* Audio recordings are converted into verbatim narrative transcripts.

2. *Thematic Coding:* Transcripts are coded to extract core themes, in vivo codes, and recurrent experiential patterns.
3. *Actant Categorization:* Narratives are systematically classified into human actants and non-human (technical/material) actants.
4. *Hybrid Association Analysis:* ANT analytical procedures trace relational associations among human and non-human entities, determining how these assemblages reinforce or destabilize service delivery networks.
5. *Sociotechnogram Mapping:* Heterogeneous actor configurations are mapped graphically to illustrate relational patterns, key actants, technical mediations, points of friction, and network stability.
6. *Independent Synthesis:* ANT produces a standalone qualitative account detailing the mechanisms of hybrid network operations and specific actor roles.

Stage 3: Methodological Integration via Joint Display Matrix

The integration stage occurs through a Joint Display Matrix (Table 7). Statistically significant metrics (β and p-values) from the SEM structural model identify *which* factors are structurally critical, while ANT hybrid association maps elucidate *how* concrete interactions among human and material components produce those outcomes. Juxtaposing these complementary findings forms the empirical foundation for establishing Key Success Factors (KSFs) and strategic managerial recommendations.

Table 6. Alignment Matrix between SEM Constructs and ANT Network Nodes

Domain	SEM Construct	Human ANT Actors	Non-human ANT Actors	ANT Translation Process Focus
SERVQUAL	Tangibles	Customers, service officers, management.	Outlets, facilities, vehicles, equipment, applications	How facilities and artifacts are perceived and utilized to construct service credibility
SERVQUAL	Reliability	Service officers, couriers, customers, management	SOPs, logistics systems, tracking systems, databases	Alignment of service promises with actual performance consistently
SERVQUAL	Responsiveness	Customers, customer service, couriers	Communication channels, applications, WhatsApp, complaint systems	How needs/complaints are translated into service actions
SERVQUAL	Assurance	Service officers, couriers, management, customers	SOPs, security systems, claim mechanisms	Formation of security and trust through service competence and protection mechanisms
SERVQUAL	Empathy	Customers, service officers	Assistance channels, service procedures	Negotiation between individual customer needs and solutions provided by the company
LSQ	Order Timeliness	Couriers, sorting officers, customers	Vehicles, schedules, routes, tracking systems, packages	Temporal coordination among actors to ensure goods arrive according to commitments
LSQ	Order Accuracy	Service officers, couriers, senders, recipients	Labels, receipts, barcodes, addresses, databases, packages	Alignment of identity, destination, information, and shipment objects

Domain	SEM Construct	Human ANT Actors	Non-human ANT Actors	ANT Translation Process Focus
LSQ	Order Condition	Couriers, warehouse/sorting officers, customers	Packaging, warehouses, vehicles, packages	Maintaining the physical integrity of goods throughout the distribution network
ICT	Digital Information	Customers, IT officers, management	Websites, applications, databases, tracking systems	Transformation of physical shipment events into accurate and accessible digital information
ICT	Online Procedure	Customers, service officers	E-booking, e-payment, aplikasi, sistem komplain	Shifting transaction processes from manual interactions toward digital procedures
ICT	E-Commerce Integration	Customers, merchants, logistics companies	E-commerce platforms, APIs/information systems, tracking systems	Synchronization of data and activities across platforms to produce integrated services
MOC	Brand Awareness	Customers, companies	Brand names, communication media, digital platforms	Formation of brand recognition and recall through multiple touchpoints
MOC	Brand Trust	Customers, employees, management	SOPs, tracking systems, service guarantees	Stabilization of trust through consistency between promises and network performance
MOC	Brand Image	Customers, companies, service officers	Brand identity, facilities, technology, media	Accumulation of experiences and network representations into corporate image
CRM	Purchase Decision	Customers, service officers/merchants	Applications, tariff information, tracking systems, e-commerce platforms	Mobilization of various service qualities into decisions to select service providers
CRM	Satisfaction	Customers and all service actors	Overall service artifacts and systems	Stabilization of customer experience when the network meets or exceeds expectations
CRM	Loyalty	Customers, companies, user communities	Service platforms, CRM systems, communication channels	Maintenance of relational networks to encourage continuous reuse and recommendations

Interpretation Results

The Joint Display Matrix yields three analytical possibilities: (1) Convergence: Occurs when a statistically robust and significant SEM path is corroborated by ANT evidence demonstrating a stable, well-aligned actor-network; (2) Complementarity: Occurs when SEM identifies a significant structural link, and ANT reveals the fine-grained socio-material mechanisms explaining why and how that relationship manifests; (3) Divergence: Occurs when statistical path estimates do not align with on-the-ground network configurations. Divergence is not treated as a methodological flaw; rather, it uncovers tensions between aggregate population patterns and localized, context-specific relational experiences.

Criteria for Synthesizing Findings and Formulating KSFs

The synthesis prioritizes convergent–complementary findings to guarantee the robustness and validity of formulated Key Success Factors (KSFs) and strategic recommendations. When SEM verifies statistical significance and ANT confirms successful translation and network stability, the factor is formally designated as a priority KSF. Conversely, divergent findings such as high statistical scores accompanied by network betrayal (*trahison*) or breakdowns in the field are neither discarded nor artificially forced into KSF status to prevent analytical bias. Instead, divergent outcomes are conceptualized as *network vulnerabilities* and *boundary conditions*, illuminating points of relational breakdown (*network breakdown*), explaining exceptional outlier dynamics, and providing an empirical baseline for risk mitigation strategies and future research agendas.

CONCLUSION

This study proposes an integrative SEM–ANT framework to analyze logistics services from structural and relational perspectives. SEM examines the relationships among key constructs, while ANT explores interactions between human and non-human actors. Through a Convergent Parallel Mixed Methods design, the framework integrates quantitative and qualitative findings to identify Key Success Factors (KSFs) and develop service improvement strategies. Its novelty lies in combining 17 constructs related to service quality, logistics performance, information and communication technology (ICT), brand equity, customer satisfaction, and loyalty within a multi-level service ecosystem. Academically, the framework extends KSF analysis beyond statistical significance by incorporating organizational processes, technological capabilities, infrastructure, and actor networks. Practically, it assists logistics managers in identifying network-level factors that influence service performance. However, the framework remains conceptual and requires empirical validation due to its model complexity and the flexible relationships between constructs and actors. Future research should test the framework across different logistics providers, regions, and service types using quantitative and qualitative approaches to evaluate its validity, transferability, and practical effectiveness.

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