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## Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness

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**Abstract:** This study examines how logistics digitalization in small and medium-sized enterprises (SMEs) engaged in e-commerce shapes customer satisfaction and business competitiveness through specific operational mechanisms. Using a structured narrative review, the research integrates conceptual findings into an analytical framework. The methodology consists of a bibliographic search (2020-2025), followed by a thematic synthesis of 69 abstracts selected after applying exclusion criteria. The analysis shows that digital logistics practices create value when they activate four mechanisms: visibility, synchronization, accuracy, and efficiency/automation. These mechanisms enhance customer satisfaction by improving transparency, reliability, personalization, and service speed, while strengthening competitiveness through cost reduction, scalability, and market differentiation. The findings also reveal that the effectiveness of these mechanisms depends on digital maturity, cultural adaptability, and absorptive capacity, as well as on broader institutional conditions. Limited investment, skill shortages, regulatory gaps, and infrastructural inequalities constrain SMEs' ability to fully scale digital tools, underscoring that technological adoption alone is insufficient without organizational readiness and institutional support. By articulating a framework of mechanism-based pathways linking digital practices to customer satisfaction and competitiveness, the study advances theoretical understanding beyond descriptive taxonomies and toward explanatory models of digital logistics. The study concludes by proposing a staged digital maturity model as a supporting tool to identify the current level of logistics capabilities of SMEs and to project scaling pathways toward higher levels of integration, automation, and analytical sophistication.

### 1 Introduction

Digital transformation stands as a key driving force in 21<sup>st</sup> century business evolution, profoundly reshaping how organizations operate and deliver value to customers through e-commerce. This process spans from product design to raw material management, manufacturing, distribution, and after-sales service, posing particular challenges for small and medium-sized enterprises (SMEs), which must rapidly adapt to a highly competitive and technologically demanding environment [1-2]. In this context, emerging technologies such as artificial intelligence, machine learning, the Internet of Things, and Big Data analytics reconfigure logistics operations, requiring new technical competencies and an organizational culture oriented toward innovation [3-4].

Digital logistics management emerges as a key strategy to coordinate business operations, optimize resources, and respond to growing expectations for traceability, personalization, and delivery times [5-6]. Several studies demonstrate that practices such as real-time tracking, automation, and dynamic reconfiguration of the supply chain directly influence customer satisfaction and loyalty [7-8]. However, SMEs face structural barriers that hinder technological adoption, including financial constraints, shortages in human capital, and organizational resistance to change [9-10]. Regarding competitiveness, the literature agrees that e-commerce and logistics digitalization can act as catalysts for sustainability and growth, provided a minimum level of digital maturity is in place [11-12].

While literature advances in identifying key practices and technologies associated with Logistics 5.0, a gap remains in understanding how these tools translate into tangible and sustainable competitive advantages for SMEs in emerging economies. Within this context, the present study aims to map and synthesize the impact of logistics digitalization in e-commerce SMEs on customer satisfaction and business competitiveness, considering the operational mechanisms involved. Accordingly, the study seeks to answer the central research question: How do digital logistics practices in e-commerce SMEs generate impact mechanisms that influence customer satisfaction and business competitiveness? To

## Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness

Rodrigo Gallardo-Canales, Ester Guijarro, Cristina Santandreu-Mascarell

address this, the research offers a dual contribution. First, it develops an integrative framework linking digital practices with logistics mechanisms such as visibility, synchronization, accuracy, and automation through organizational outcomes. Second, it proposes a typology of practices and barriers to guide managerial decision-making in digital transformation processes.

Given the emerging and multidimensional nature of digital logistics management in e-commerce SMEs, this study adopts a structured narrative review as its methodological approach, aimed at conceptual synthesis and the mapping of relevant logistics practices. This type of review enables a critical articulation of the state of the art by integrating heterogeneous findings, identifying thematic patterns, and constructing an analytical framework that links digital practices with operational mechanisms and organizational outcomes, prioritizing interpretive conceptualization over statistical synthesis. Unlike a systematic review, this approach does not seek quantitative exhaustiveness but rather interpretive coherence and methodological transparency, grounded in explicit criteria for information search, selection, and organization. Its purpose is to foster a transversal reading of the academic corpus, facilitating comparative analysis across levels of digital maturity, logistics capabilities, and performance in competitiveness and customer service.

Accordingly, the study draws on a sample of 69 peer-reviewed articles indexed between 2020 and 2025, selected through thematic criteria and organized into a conceptual cartography that visualizes the causal thread connecting digital logistics practices to their corresponding operational mechanisms and to their outcomes in satisfaction and competitiveness within SMEs.

This study contributes to existing literature in three ways. First, it offers a consolidated synthesis of fragmented digital logistics frameworks, addressing the conceptual dispersion that characterizes current research. Second, it advances theoretical understanding by articulating mechanism-based pathways linking digital practices to customer satisfaction and competitiveness and, lastly, it proposes an integrative model of staged digital maturity tailored to the realities of e-commerce SMEs, as a preliminary tool for diagnostics and planification.

## 2 Literature review

Digital logistics management in e-commerce SMEs has gained prominence as a strategic axis for addressing the demands of traceability, efficiency, and personalization from contemporary consumers. However, the specialized literature reveals significant conceptual dispersion, lacking integrative frameworks that systematically link digital practices with the operational mechanisms that support them and the organizational outcomes they generate. This study addresses that gap by proposing a theoretical framework articulated across three dimensions: digital logistics management practices, logistics mechanisms, and outcomes. These dimensions, derived from thematic analysis of the academic corpus, enable the mapping and synthesis of the impact of logistics digitalization on customer satisfaction and business competitiveness.

### 2.1 *Digital logistics management practices*

Digital logistics management practices are defined as the set of actions, processes, and technologies aimed at planning, executing, and controlling logistics operations through digital tools [13]. These practices optimize supply chain efficiency, traceability, flexibility, and responsiveness, in alignment with the growing demands of e-commerce [14]. Key enabling technologies include real-time tracking, warehouse automation, and predictive logistics [6].

These practices can be classified in the following way [14–15]:

- Logistics Function: inventory management, distribution, reverse logistics
- Technological Level: low, medium, or high automation
- Expected Impact: cost reduction, delivery speed, service personalization
- SME Type: retail, food service, professional services

This classification enables the contextualization of practices according to industry sector and level of technological maturity, facilitating comparative analysis. From a strategic standpoint, the implementation of digital logistics solutions serves as a pathway to competitive differentiation for SMEs, particularly in saturated markets [12].

### 2.2 *Logistic mechanisms*

Logistic mechanisms can be understood as operational processes that mediate between technological adoption and organizational outcomes, facilitating visibility, synchronization, and automation across the supply chain. These mechanisms enable the translation of digital capabilities into competitive advantages, particularly in volatile and highly disruptive environments [16]. Within the scope of this research, these mechanisms function as impact vectors, helping to explain how logistics technologies influence customer experience and business competitiveness.

The identified mechanisms include:

- Visibility: the ability to monitor the status of orders, inventories, and logistics routes in real time
- Synchronization: dynamic alignment between supply, demand, and logistics operations
- Accuracy: precision in data management, delivery times, and product availability
- Automation: replacement of manual tasks with digital processes that enhance efficiency and reduce errors

## Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness

Rodrigo Gallardo-Canales, Ester Guijarro, Cristina Santandreu-Mascarell

These mechanisms act as mediators between technological adoption and expected outcomes, and their activation depends on the firm’s level of digital maturity [11]. Empirical literature demonstrates that practices such as continuous monitoring and personalized deliveries enhance the perceived value of service [7-8].

### 2.3 Organizational outcomes

The organizational outcomes derived from digital logistics management concentrate on two key dimensions: customer satisfaction and business competitiveness. The former relates to the firm’s ability to deliver agile, traceable, and personalized shopping experiences, while the latter is associated with operational efficiency, logistics resilience, and adaptability to changing environments.

Recent studies show that the quality of logistics services directly influences customer loyalty, particularly among consumer segments that value traceability and delivery flexibility [5, 7]. Regarding competitiveness, logistics digitalization has been shown to act as a catalyst for growth and sustainability, provided that a minimum foundation of technological and organizational capabilities is in place [10,12].

This theoretical framework offers a structured view of the relationship between digital practices, logistics mechanisms, and organizational outcomes, providing a conceptual basis for comparative analysis and managerial decision-making regarding the digital maturity level and innovation capacity of SMEs. By articulating these three dimensions, this study contributes to understanding how logistics digitalization in e-commerce SMEs functions as a strategic lever for enhancing customer satisfaction and business competitiveness, addressing a research gap that remains unresolved in the specialized literature.

## 3 Methodology

The review was conducted in two complementary stages, following a structured narrative review approach oriented toward conceptual synthesis and thematic mapping. First, a bibliographic search was carried out in December 2024 and July 2025, targeting peer-reviewed articles published in English between the first half of 2020 and the first half of 2025. The search was conducted across the Web of Science (WoS), Scopus, and ErihPlus databases using the following Boolean operators: (Logistics management OR Logistical management) AND digital transformation AND (ecommerce OR electronic commerce). This strategy yielded an initial corpus of 475 academic articles in English. The selected time frame corresponds to the post-COVID-19 surge in e-commerce, a period marked by intensified digital transformation processes in logistics management and a significant increase in relevant scientific output.

To delimit the scope of analysis, thematic exclusion criteria were applied to filter out studies focused on sustainability, environmentalism, green information technologies, health, education, public policy, taxation, and cryptocurrencies, as these topics fall outside the scope of a review centered on digital logistics management in SMEs. These criteria were operationalized through the identification of exclusionary keywords in titles, abstracts, and descriptors, complemented by manual screening to ensure thematic relevance. After removing duplicates and applying these filters, a final sample of 69 articles was selected for analysis.

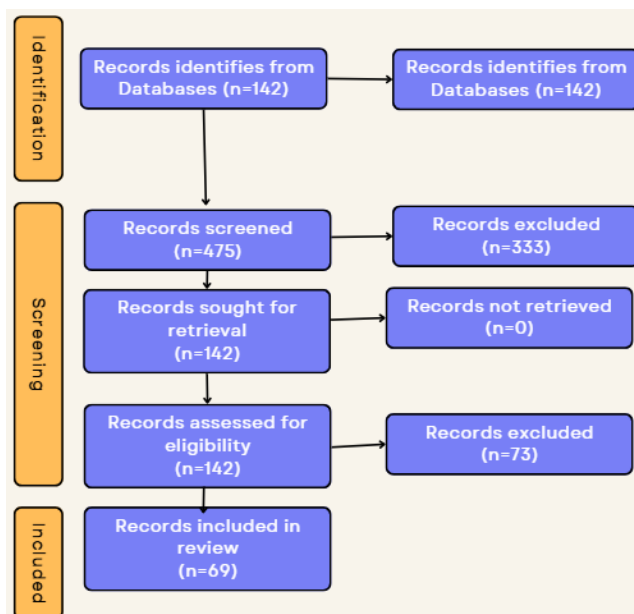


Figure 1 Identification of studies via databases and registers  
Source: Figure developed by the author.

**Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness**

Rodrigo Gallardo-Canales, Ester Guijarro, Cristina Santandreu-Mascarell

Second, the titles, abstracts, and keywords of the selected articles were thematically analyzed and narratively synthesized to identify recurring digital practices and conceptual challenges that present themselves as research gaps. This synthesis enabled the construction of a conceptual framework that clusters logistics practices and mechanisms according to their operational and strategic orientation, understood as the intended impact, and subsequently allows for linking the identified challenges to the digital maturity level of the firms. The framework proposed in the discussion responds to these gaps by providing an integrated reading of the state of the art as outlined in the theoretical review, contributing both to comparative research and to managerial decision-making in digital transformation processes.

**4 Results**

The study’s findings are presented through a descriptive synthesis aimed at identifying and characterizing the main emerging themes within the analyzed corpus. This phase organizes empirical evidence and establishes patterns that serve as a foundation for the subsequent discussion, in which an interpretive synthesis will conceptually integrate the findings with the theoretical framework.

**4.1 Practices and mechanisms identifies in SMEs dedicated to ecommerce**

Digital logistics management in e-commerce is conceived as a set of actions, processes, and technologies designed to plan, execute, and control logistics operations through digital tools [13]. These practices function as enablers of efficiency, traceability, and responsiveness, and are articulated through specific mechanisms that influence both competitiveness and customer experience. The most relevant practices include:

- Collaborative Planning, Forecasting, and Replenishment (CPFR): data integration among supply chain actors to anticipate demand and adjust inventories via digital platforms
- Automated Inventory Management (VMI, JIT): replenishment systems based on actual consumption and predictive algorithms to minimize stockouts and overstock
- Warehouse Digitalization (WMS): use of sensors, QR codes, and RFID for real-time tracking and flow visualization through interactive dashboards
- Enterprise Resource Planning (ERP) and Supply Chain Management (SCM) System Integration: connection between procurement, production, and distribution through integrated systems and real-time monitoring of key performance indicators (KPIs)

These practices respond to the demands for differentiation in saturated markets and operational efficiency [12], as well as to customer satisfaction and loyalty through traceability, personalization, and delivery flexibility [7-8].

Table 1 summarizes, for each study, the dominant logistics mechanism (V/S/A/E), the expected impact, and the main implementation challenge, serving as a bridge to the practices–indicators linkage presented in Table 3.

*Table 1 Conceptual framework of logistics mechanism, intended impact, and implementation challenges*

Dominant logistic mechanism (V/S/A/E)*	Intended impact	Challenges
IA, blockchain, IoT, cloud	Improved efficiency, traceability	Heterogeneous adoption depending on digital maturity [13]
Big data, autonomous vehicles Visibility	Route optimization, operational visibility	Implementation costs [6]
IA, IoT, blockchain, ML	Strategic classification by logistics function	Low technological integration [14]
Real time tracking Accuracy	Customer loyalty, impact on Generation Z	Continuous service requirement
Traceability, flexibility Synchronization	Personalization, customer loyalty	Lack of sectoral standardization [7-8]
General digitalization Automation	Reduction of operational custos	Lack of digitally skilled human capital [9]
Resilient logistics Synchronization	Regional adaptability, sustainability	Territorial inequality in technological adoption [10]
Digital platforms Visibility Efficiency	Market Growth, Resilience Cost reduction	Limited digital capabilities in SMEs Organizational and technological barriers [11-12]

\*V = Visibility, S = Synchronization, A = Accuracy, E = Efficiency/Automation

Source: Author’s own elaboration.

Table 1 presents a framework designed to classify the selected articles according to the contributing authors; the logistics mechanisms, understood as digital logistics management practices; the intended outcomes of their

**Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness**

Rodrigo Gallardo-Canales, Ester Guijarro, Cristina Santandreu-Mascarell

implementation—focused on customer service and competitiveness through operational cost reduction, route optimization, among others; and, finally, the most common implementation challenges.

**4.2 Impacts and outcomes on customer satisfaction and business competitiveness**

Building on the synthesis presented in Table 1, Table 2 operationalizes these impacts into measurable indicators of customer satisfaction and business competitiveness.

*Table 2 Practices and indicators of customer satisfaction and business competitiveness in SMEs*

Logistics Practices	Customer Satisfaction Indicators	Business Competitiveness Indicators	N° of studies
<b>Inventory management, transportation, tracking, and delivery (Big Data, AI, IoT, drones, omnichannel strategies, smart warehousing, TOE frameworks)</b>	Speed and reliability of delivery Order transparency Service personalization	Operational efficiency Reduction of logistics costs Market differentiation	24
<b>Process automation and digital strategies</b>	Seamless shopping experience Shorter order wait times Greater consistency in service	Operational scalability Flexibility and adaptability to change Innovation in business models	18
<b>Training and competency management for operating disruptive technologies</b>	Faster and more personalized customer service Greater customer trust in service	Development of internal capabilities	27

Source: Author's own elaboration.

The analysis of the data presented in Table 2 reveals that inventory management, transportation, tracking, and delivery—supported by technologies such as Big Data, Artificial Intelligence, IoT, drones, omnichannel strategies, and smart warehousing—constitute the most extensively studied core in the literature, with 24 studies. These practices are directly associated with improvements in customer satisfaction by ensuring faster and more reliable deliveries, enhanced order traceability, and personalized service. In parallel, they are linked to business competitiveness indicators such as operational efficiency, reduction of logistics costs, and market differentiation in highly competitive environments.

Secondly, process automation and the implementation of digital strategies are supported by 18 studies, highlighting their role in generating smoother shopping experiences, with fewer errors and greater consistency in service delivery. From a competitive perspective, these practices enable SMEs to scale operations, adapt more flexibly to environmental changes, and explore innovations in their business models.

Finally, the literature also emphasizes the importance of training and talent management for operating disruptive technologies, with 27 studies underscoring their impact on customer satisfaction through faster and more personalized service, as well as the development of customer trust. In terms of competitiveness, the formation of internal capabilities is recognized as a key factor in sustaining digital transformation over time and ensuring that logistics innovation translates into stable and scalable organizational advantages.

**4.3 Integrative insights**

Figure 2 illustrates the number of studies addressing challenges related to internal digital transformation, internal cultural transformation, and external factors beyond the company.

The implementation of digital logistics management is conditioned by a set of interdependent organizational and institutional factors that influence the extent to which digital tools become improvements in customer service and business competitiveness. Rather than isolated barriers or challenges, the results of this study reveal a series of integrative dynamics that can explain how digital transformation unfolds within businesses and across their operating environments.

- **Digital Maturity as a Foundational Enabler of Logistical Transformation:** The adoption of advanced technologies such as Big Data, Internet of Things (IoT), Artificial Intelligence (AI), traceability systems, and personalization tools depends critically on the business' level of digital maturity. This maturity reflects the capacity to invest in, integrate, and scale digital solutions, a condition that remains limited in many small and medium-sized businesses due to structural constraints in technological and operational modernization [17-42]. Consequently, digital maturity functions as a moderating mechanism that determines whether digitalization efforts effectively enhance logistical efficiency, customer service responsiveness, and competitive positioning.
- **Cultural Transformation as the Core Mechanism Enabling Technological Adoption:** The literature consistently highlights that technological implementation is contingent upon a deeper process of cultural transformation. Openness to innovation, willingness to embrace change, and the development of digital competencies across organizational levels constitute the cultural foundations that enable the effective integration of emerging technologies [20,21,28,29,32,33,38,39,43-52]. Cultural adaptability thus emerges as a central mechanism, shaping

**Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness**

Rodrigo Gallardo-Canales, Ester Guijarro, Cristina Santandreu-Mascarell

not only the pace of digital adoption but also the capacity of businesses to leverage digital tools for improved customer experience and competitive differentiation.

- **Gaps Between Technological Availability and Organizational Absorptive Capacity:** A recurring pattern in the literature is the misalignment between the rapid evolution of digital technologies and the limited absorptive capacity of many organizations. This gap appears as insufficient investment, shortages of digital skills, and difficulties in reconfiguring processes to accommodate disruptive tools [17-52]. As a result, the competitive benefits associated with digital logistics such as enhanced traceability, personalization, and operational agility remain unrealized in businesses that lack the dynamic capabilities required to internalize and operationalize technological innovations.
- **Institutional Insufficiencies as Systemic Constraints on Digitalization:** Beyond internal dynamics, the external environment plays a decisive role in shaping the trajectory of digital transformation. Insufficient legislative support, limited access to infrastructure, and scarce training and funding mechanisms constrain businesses’ ability to develop the competencies needed to manage disruptive technologies [37,40,41,47,53-69]. Additionally, regulatory voids concerning ethical, privacy, and cybersecurity requirements hinder the responsible and secure deployment of digital tools. These institutional gaps constitute systemic constraints that restrict the scalability and sustainability of digital logistics initiatives.
- **Weak Strategic Alignment Between Digitalization, Customer Service, and Competitiveness:** Although digital technologies hold significant potential to enhance service quality and competitive performance, many organizations struggle to align digital initiatives with strategic objectives related to customer experience and market positioning. Cultural, technological, and regulatory limitations hinder the intent to digitalize and the capacity to generate tangible value, resulting in a conceptual and practical gap in both managerial practice and academic research [17-69]. Strengthening this articulation is essential for ensuring that digital logistics investments translate into measurable improvements in customer satisfaction and competitive advantage.

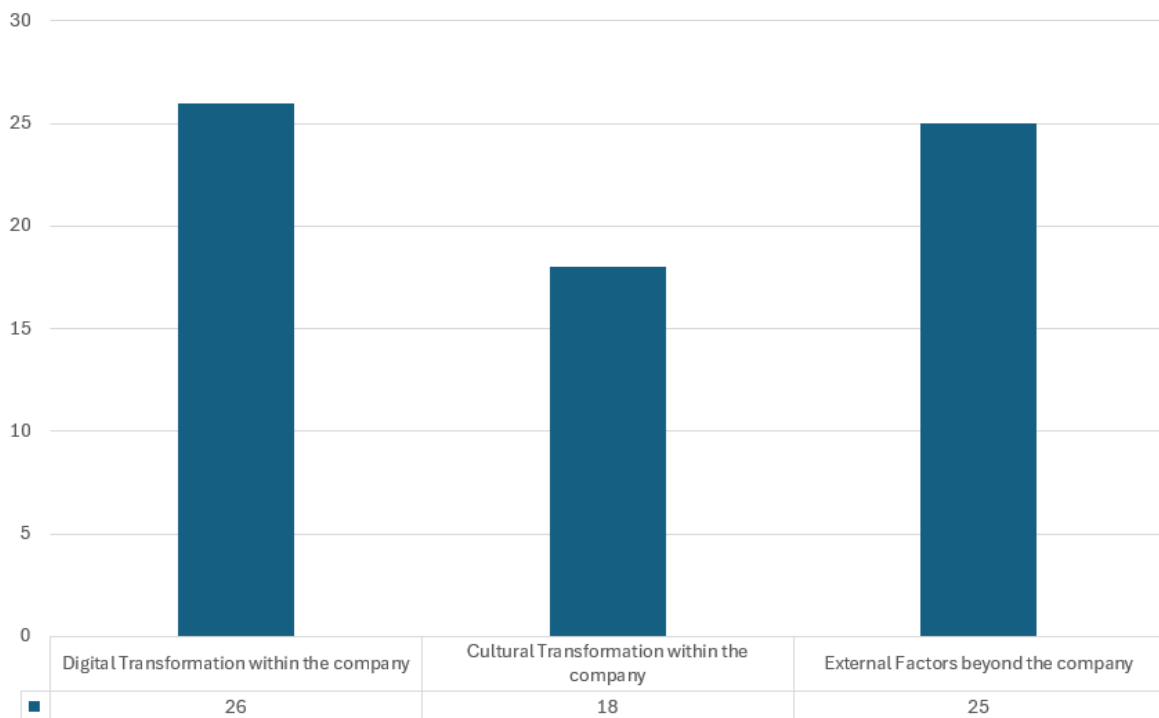


Figure 2 Number of studies categorized by type of challenge

**5 Discussion**

The structured narrative review reveals a consistent pattern across the analyzed studies: digital logistics practices in SMEs dedicated to e-commerce generate value not through isolated technological tools, but through the interaction of specific logistics mechanisms. These mechanisms: visibility, synchronization, accuracy, and efficiency/automation shape customer satisfaction and business competitiveness. They operate as mediators between technological adoption and performance outcomes, and their effectiveness depends on the organizational and institutional conditions identified in the integrative insights.

## Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness

Rodrigo Gallardo-Canales, Ester Guijarro, Cristina Santandreu-Mascarell

### 5.1 Interpretation of the pattern of results: implications for customer satisfaction and competitiveness

Across the review, customer satisfaction emerges as a factor given by speed, reliability, transparency, and personalization, while competitiveness is driven by operational efficiency, cost reduction, scalability, and differentiation. The results show that digital logistics practices consistently reinforce these dimensions, but their impact is uneven and moderated by digital maturity, cultural adaptability, and absorptive capacity.

Inventory management, transportation, tracking, and delivery, supported by Big Data, AI, IoT, drones, omnichannel strategies, and smart warehousing, constitute the most influential cluster of practices. Their prominence in 24 studies underscores that customer satisfaction in e-commerce logistics is fundamentally operational. This means that customers reward businesses that deliver quickly, transparently, and reliably. These same practices enhance competitiveness by reducing costs, optimizing routes, and enabling differentiation in saturated markets.

Process automation and digital strategies, relevant in 18 studies, contribute to smoother shopping experiences and greater service consistency, reinforcing the idea that operational fluidity is a precursor to customer loyalty. Competitively, automation enables SMEs to scale operations and adapt to environmental volatility, aligning with the literature on dynamic capabilities.

Finally, training and competency development, throughout 27 studies, highlight that human capital remains central to digital transformation. Faster, more personalized service and increased customer trust depend on employees' ability to operate disruptive technologies. Competitiveness, in turn, is sustained when internal capabilities evolve alongside technological change.

Taken together, these patterns confirm that digital logistics practices generate value only when businesses possess the cultural, organizational, and institutional conditions to absorb and operationalize them, which are reflected in five integrative insights.

### 5.2 Links between logistics mechanisms (V/S/A/E) and outcomes on customer service and competitiveness

The mechanisms identified in Table 1, Visibility (V), Synchronization (S), Accuracy (A), and Efficiency/Automation (E), provide a conceptual bridge between digital practices and performance outcomes. Each mechanism activates a distinct pathway through which digital logistics influences customer satisfaction and competitiveness.

- **Visibility (V):** Visibility mechanisms are enabled by Big Data, IoT, real-time tracking, and digital platforms and enhance order transparency, traceability, and customer follow-up. In this sense, customers perceive transparent operations as more reliable, which increases trust and satisfaction (Visibility → Trust → Satisfaction) and businesses gain real-time situational awareness, enabling route optimization and cost reduction (Visibility → Operational insight → Competitiveness).
- **Synchronization (S):** Synchronization mechanisms are supported by CPFR, ERP–SCM integration, and resilient logistics system, which coordinate flows across the supply chain. In this sense, coordinated processes reduce delays and variability, improving perceived service quality (Synchronization → Delivery consistency → Satisfaction), and SMEs can respond more quickly to demand fluctuations and environmental disruptions (Synchronization → Agility and adaptability → Competitiveness).
- **Accuracy (A):** Accuracy mechanisms are driven by real-time tracking, predictive analytics, and automated inventory systems and ensure precise execution of logistics tasks. As a result, accurate order preparation and delivery reduce errors and enhance customer loyalty, especially among digitally demanding segments such as Generation Z (Accuracy → Reliability → Satisfaction), and precision minimizes operational losses and strengthens cost efficiency (Accuracy → Reduced waste and rework → Competitiveness).
- **Efficiency and Automation (E):** Efficiency mechanisms are enabled by automation, WMS, robotics, and digitalization optimize resource use and streamline operations. This implies that shorter wait times and seamless experiences improve customer perceptions (Automation → Faster service → Satisfaction) and automated processes support growth and reduce labor-intensive bottlenecks (Automation → Scalability and cost reduction → Competitiveness).

The effectiveness of the mechanisms examined is inherently conditioned by the organizational and institutional context in which they are implemented. First, the organization's level of digital maturity determines the extent to which visibility and automation tools can be fully implemented, directly shaping their operational reach and depth. Cultural transformation also plays a central role in enabling synchronization and accuracy, as it fosters openness to new practices, technologies, and competencies. Similarly, absorptive capacity emerges as a critical factor, as it defines the organization's ability to translate technological availability into concrete operational improvements. This process is not automatic; it requires cognitive structures, routines, and prior learning that allow digital knowledge to be internalized and exploited. In parallel, institutional support influences the scalability of these practices, particularly for SMEs that often face regulatory, financial, or infrastructural constraints limiting the full adoption of digital solutions.

### 5.3 Supporting diagnostic: digital maturity model

Strategic alignment acts as an integrating element that prevents the mechanisms from being implemented as isolated tools. Instead, embedding them within a coherent value-creation logic enables them to contribute synergistically to organizational objectives.

Understood as a whole, these elements show that the mechanisms of visibility, synchronization, automation, and standardization do not operate independently or within a purely technical domain. Rather, they are embedded in a socio-technical system in which organizational readiness and institutional conditions determine their actual capacity to enhance customer satisfaction and strengthen competitiveness.

The analysis reveals that the implementation of digital logistics management is not constrained by isolated barriers but by the interaction and articulation of organizational maturity, cultural adaptability, absorptive capacity, and institutional support. Digital maturity and cultural transformation emerge as foundational mechanisms that condition the extent to which technological investments translate into improvements in customer service and competitiveness. At the same time, the persistent gap between technological availability and organizational capabilities, together with systemic institutional insufficiencies, limits business' ability to scale and sustain digital initiatives. These dynamics highlight a broader strategic misalignment between digitalization efforts and value creation objectives, suggesting that the competitive potential of digital logistics depends less on the mere adoption of technologies and more on the coherence between internal capabilities, cultural readiness, and the external regulatory environment. This integrative perspective provides a basis for discussing how businesses and policymakers can strengthen the conditions necessary for digital logistics to generate meaningful and sustained competitive advantages.

Figure 3 illustrates the interrelations between digital transformation and cultural transformation, and how these converge in strengthening the organizations' capacity for innovation and coordination, oriented toward the consolidation of strategic projects.

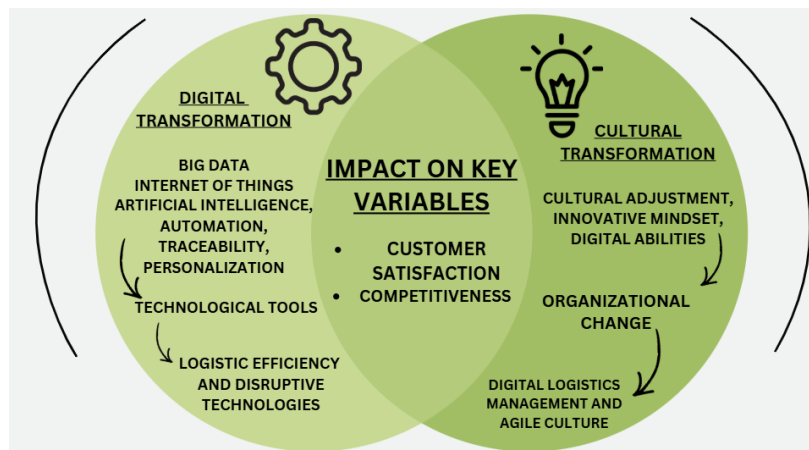


Figure 3 Articulation of implementation challenges in digital logistics management focused on customer service and competitiveness

Source: Author's own elaboration.

Figure 3 illustrates that both digital transformation and cultural transformation are essential for scaling the digital maturity of firms, as the supporting elements for a diagnostic tool to diagnose digital maturity in Table 3. In Figure 3, each axis impacts customer service and competitiveness; however, they face distinct challenges. On one hand, cultural transformation requires organizational change, managing change and fostering a willingness to reconfigure agile mindsets are significant barriers that firms must overcome. On the other hand, digital transformation demands key investments in both operational technologies and machinery, aimed at improving logistics efficiency and mastering disruptive technologies.

In this sense, firms must develop differentiated competencies according to their resources and context, with strategic management, innovation, and continuous training being critical factors for organizational survival and sustained growth [68,69]. This need becomes increasingly urgent in business cycles that are shorter and more complex, shaped by technological acceleration and market volatility.

The willingness to embrace change and the development of digital competencies across all levels of the firm must confront the reconfiguration of values, practices, and mindsets among employees throughout the organizational structure, in order to respond effectively to the constant evolution of emerging technologies [17-42].

During the growth stage, firms require financing and commercial strategies that enable them to attract customers and investors, achieve economies of scale, and compete with established players. The management phase is associated with

**Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness**

Rodrigo Gallardo-Canales, Ester Guijarro, Cristina Santandreu-Mascarell

financial stability, allowing for strategic decisions regarding investment or divestment based on competitive positioning. However, the lack of continuous adaptation may lead to organizational decline, evidenced by decreasing sales and the need for structural adjustments.

This process is directly linked to digital transformation, which demands significant technological and operational investments. Firms acknowledge the need to incorporate advanced tools such as Big Data, Internet of Things (IoT), Artificial Intelligence (AI), traceability systems, and personalization technologies, all aimed at optimizing logistics efficiency and sustaining competitive advantages in dynamic environments. These technological solutions target operational effectiveness and organizational productivity, yet their implementation faces a major challenge: limited investment in digitalization and operational modernization processes, particularly within the context of small and medium-sized enterprises [20,21,28,29,32,33,38,39,43-52].

The survival phase, understood from a Darwinian perspective, requires adaptive capacity through innovation, strategic alliances, and product renewal. It is worth noting that, in adverse contexts, firms that strategically adapt through partnerships, progressive digitalization, and an innovative culture are more likely to advance toward growth and consolidation stages. However, on their path to consolidation, firms must respond to external pressures that directly affect their viability and are not always within their control [37,40,41,47,53-69].

The external pressures faced by SMEs in logistics digitalization processes manifest across three critical dimensions: regulatory-political, sociocultural, and technological. On the regulatory front, fiscal, labor, and technological changes directly affect operational costs and strategic planning. In particular, regulations concerning e-commerce, data protection, and cybersecurity have become increasingly relevant in digital contexts, demanding both operational efficiency and ethical responsibility in the use of disruptive technologies.

From a sociocultural perspective, shifts in consumer preferences, alongside demographic dynamics such as population aging, migration, and demands for inclusion, compel firms to reassess their business models and redefine their target markets.

In the technological domain, the rapid evolution of tools such as Artificial Intelligence (AI), Internet of Things (IoT), and big data analytics imposes constant pressure to adapt. However, many SMEs face significant gaps in infrastructure and human capital development, which limit their effective access to these technologies. The accelerated obsolescence of traditional processes and the need for ongoing reinvestment create a challenging environment that demands strategic vision and organizational transformation capacity.

This aligns with the classification of firms by degree of innovation, categorized into three levels, leading, modest, and non-innovative enterprises [70,71]. This classification corresponds to the observed levels of digital maturity and is directly related to the barriers to open innovation in firms, which are explained across three dimensions: cognitive, behavioral, and institutional. These levels reflect that logistics innovation does not depend solely on technological availability, but also on organizational culture, leadership, and internal incentives. This implies the need for a preliminary stage prior to the implementation of digital tools, one that relates to the maturity levels of entrepreneurs, which condition their openness to innovation, understanding of its benefits, and motivation to adopt it.

Once the need to access technology and pursue digital transformation and adaptive capacity is understood, it becomes essential to recognize that external factors, such as access to financing, regulatory frameworks, and institutional support, also influence the viability of innovation processes, particularly during the early stages of the business lifecycle.

Based on this articulation between theory and empirical evidence, a diagnostic tool is proposed to structure logistics innovation capacity according to the level of digital maturity. The model in Table 3 is organized as a scaled typology, ranging from a Basic level, characterized by incipient digitalization and low adaptability, to a Transformative level, marked by adaptive logistics, intelligent personalization, and intensive use of emerging technologies. Each level incorporates technological, operational, and analytical dimensions that enable the evaluation of an organization's innovative capacity and its competitive potential in digital environments.

*Table 3 Staged digital maturity model*

Digital maturity level	Degree of innovative adaptability
1. Basic	Use of isolated tools, low automation
2. Intermediate	Partial system integration, functional automation
3. Advanced	Technological synergy between areas, predictive analysis and traceability
4. Transformational	Use of AI, IoT, Big Data, Adaptive Logistics, and Personalization

*Source: Author's own elaboration.*

In Table 3, the progression from a Basic level to a Transformative one reflects not only technological adoption, but also the degree of integration, automation, and analytical sophistication that enables logistics innovation. The configuration of these levels is grounded in the business lifecycle stages [70] and aims to offer a preliminary definition to help entrepreneurs recognize the level of innovative capacity afforded by their firm's digital maturity, guiding them on how to scale toward greater capabilities and reach in terms of competitiveness and customer service.

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Rodrigo Gallardo-Canales, Ester Guijarro, Cristina Santandreu-Mascarell

Within this model, the Basic level is characterized by incipient digitalization and low adaptability. This means that digital tools are used in isolation, such as spreadsheets or non-integrated software, among others. As a result, its innovative capacity is limited. Low automation hinders process optimization, data-driven decision-making, and agile responses to environmental changes. Consequently, logistics operations are reactive, with limited traceability and a reliance on manual processes.

At the Intermediate level, functional automation and partial connectivity are present. This level is defined by partial integration of systems (ERP, WMS, CRM), enabling some degree of interoperability and coordination across departments. Accordingly, its innovative capacity is moderate, allowing for the automation of specific functions such as inventory or dispatch, which improves operational efficiency. In this context, useful information begins to be generated for decision-making, although gaps in data communication and limitations in adaptability still persist.

The Advanced level is characterized by technological synergy and predictive analytics, enabled by interconnection across logistics areas through digital platforms, with capabilities for predictive analysis and real-time traceability. As a result, its innovative capacity is high, reflected in the organization's ability to anticipate demand, optimize routes, and manage resources dynamically. This consolidates a data-driven intelligent logistics system that enables proactive responses and continuous improvement.

Finally, at the Transformative level, logistics becomes adaptive and intelligent personalization is achieved. This is defined by the intensive use of emerging technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and Big Data. Its innovative capacity is very high, as logistics become adaptive, able to personalize services, predict behaviors, and respond in real time to environmental changes. This leads to a sustainable competitive advantage, with customer-centered, resilient, and scalable logistics models.

## 6 Conclusion

This study examined the digital logistics practices adopted by SMEs engaged in e-commerce and analyzed their impacts on customer satisfaction and business competitiveness through a mechanism-based lens. The methodology employed consisted of a structured narrative review in two phases: a bibliographic search across indexed databases (WoS, Scopus, and ERIH Plus) from 2020 to 2025, followed by a thematic synthesis of the selected abstracts. The analysis enabled the construction of a conceptual framework structured by the identification of mechanism-based pathways linking digital practices to customer satisfaction and competitiveness. By articulating how visibility enhances trust, synchronization improves consistency, accuracy reduces service errors, and automation enables scalability, the study provides a conceptual model that clarifies how and why digital logistics practices generate value in e-commerce contexts. This mechanism-oriented approach advances theoretical understanding of digital logistics beyond descriptive taxonomies and toward explanatory models.

The findings show that digital logistics management is most effective when practices such as automated inventory systems, real-time tracking, omnichannel strategies, and integrated ERP–SCM platforms activate four key logistics mechanisms: visibility, synchronization, accuracy, and efficiency/automation. These mechanisms, in turn, shape customer satisfaction through transparency, reliability, personalization, and service speed, while enhancing competitiveness through cost reduction, operational scalability, and market differentiation.

The study also reveals that the value of these mechanisms is contingent on business' digital maturity, cultural adaptability, and absorptive capacity, as well as on the broader institutional environment. Limited investment, skill shortages, regulatory gaps, and infrastructural inequalities constrain the ability of SMEs to fully leverage digital tools. This underscores that the effectiveness of digital logistics practices is not inherent to the technologies themselves but emerges from the interaction between visibility, synchronization, accuracy, efficiency/automation mechanisms and the business's digital maturity, cultural adaptability, and absorptive capacity.

The study also highlights the systemic role of institutional conditions, including regulatory support, infrastructure, training programs, and ethical guidelines, in shaping the scalability and sustainability of digital transformation in SMEs. This insight contributes to institutional theory by emphasizing that digital logistics capabilities are embedded in broader ecosystems that can either enable or constrain innovation.

Ultimately, the study highlights that the competitive potential of digital logistics lies not in technology alone, but in the coherence between technological adoption, organizational readiness, and institutional support. As supporting elements, to generate value in the context of e-commerce, a staged model for digital maturity (Table 3) is proposed as a diagnostic tool for SMEs.

### Managerial implications

From a practical standpoint, the findings provide strategic inputs for decision-making in digital transformation contexts. First, it is recognized that SMEs face persistent structural barriers such as insufficient infrastructure, resistance to change, financial constraints, and shortages in human capital. These challenges must be addressed with consideration for the organizational lifecycle and institutional environment, as they directly affect the viability of innovation processes and the sustainability of technological investments. Managers can use the mechanism-based framework to prioritize

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investments that strengthen visibility, synchronization, accuracy, and automation, while policymakers can leverage institutional insights to design targeted interventions that reduce capability gaps and promote equitable digital adoption across regions and sectors. This approach facilitates the prioritization of investments, the selection of appropriate technologies, and the alignment of internal and external capabilities.

Second, it is emphasized that improvements in customer satisfaction and business competitiveness do not rely solely on the adoption of disruptive technologies, but rather on the organization's ability to integrate them strategically. This requires overcoming gaps in training, leadership, and organizational culture, as well as confronting regulatory and economic challenges. Factors such as inflation, interest rates, and access to credit directly influence SMEs' capacity for investment and expansion, particularly in economically volatile environments.

Finally, the need for public policies that promote subsidies, accessible training programs, and certifications in digital logistics management is underscored. Such measures can foster virtuous linkages between the productive sector, academic institutions, and government agencies. This articulation has the potential to strengthen a culture of collaborative innovation, enabling SMEs to compete in the digital economy in an ethical, inclusive, and sustainable manner.

It is worth noting that this emerging conceptual framework offers a preliminary definition oriented toward business practice and opens the possibility of advancing toward integrative and comparative reviews, both regional and national, that allow for the contrast of digital maturity patterns and innovative capacities across different contexts. In doing so, gaps and opportunities can be identified for future research that deepens the relationship between logistics digitalization, competitiveness, and service quality, contributing to the academic debate as a complement to previous theoretical syntheses in the field.

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**Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness**

Rodrigo Gallardo-Canales, Ester Guijarro, Cristina Santandreu-Mascarell

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**Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness**

Rodrigo Gallardo-Canales, Ester Guijarro, Cristina Santandreu-Mascarell

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**Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness**

Rodrigo Gallardo-Canales, Ester Guijarro, Cristina Santandreu-Mascarell

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**Mechanisms of digital logistics: how e-commerce SMEs improve logistics service quality and competitiveness**

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**Review process**

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