

Research Article

Implementing Digital Technology in Logistics and Supply Chain to Increase Business Competitiveness and Innovation

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Abstract

In the context of increasing global competition, Indonesian companies are under pressure to improve their logistics and supply chain systems. Digital technologies such as the Internet of Things (IoT), artificial intelligence (AI), enterprise resource planning (ERP), cloud-based supply chain management (SCM), and blockchain have become strategic necessities rather than optional tools. This study aims to evaluate the effectiveness of digital technology adoption in enhancing efficiency, transparency, speed, and sustainability in logistics, while also examining its impact on competitiveness and innovation. Using a qualitative literature review method, the study synthesizes academic articles, policy documents, and industry reports published in the last five years. The findings demonstrate that IoT and AI improve real-time tracking, demand forecasting, and inventory stability; ERP and cloud-based SCM enhance data integration and visibility; while blockchain significantly increases transparency and supports sustainability through traceability and carbon accounting. Case studies such as Maersk, DHL, and Amazon show that firms integrating these technologies achieve substantial improvements in operational performance, customer trust, and innovative business models. However, successful implementation requires not only technical investments but also organizational readiness, governance frameworks, and stakeholder collaboration. The study concludes that holistic digital transformation in logistics provides a pathway for Indonesian industries to strengthen competitiveness and foster sustainable innovation.



Keywords: Digital Supply Chain, Business Competitiveness, Innovation.

INTRODUCTION

Indonesia is facing increasing global competitive pressures, pushing companies to strengthen their logistics and supply chains through digital technology (Dinasyah & Takaya, 2025). The application of the Internet of Things (IoT), artificial intelligence (AI), blockchain, and big data analytics has been proven to enhance efficiency, transparency, and the speed of product flows (Dinasyah & Takaya, 2025). In the era of Industry 4.0, supply chain transformation is no longer optional but rather a strategic necessity to maintain business competitiveness (Gusti et al., 2024).

Digital technology has become a crucial catalyst in driving greener and more sustainable economic growth through digital economic transformation. A study by Dasa Febriyanti et al. (2024) highlights that Indonesia's digital economic transformation—including e-commerce, fintech, and business digitalization—enhances efficiency, productivity, and environmental awareness, while reducing the carbon footprint and creating new job opportunities. Furthermore, Kartiasih et al. (2025) found that digital technology affects environmental quality; for instance, computer ownership tends to worsen environmental quality due to energy consumption and electronic waste, but improvements in GRDP and education can mitigate these negative effects.

Beyond its economic and environmental impacts, digital technology also plays an important role in shaping smart cities, supporting SMEs, and contributing to the achievement of SDGs. Rachmawati et al. (2024) discuss concepts such as the metaverse and digital twins in the context of Indonesia's new capital city (IKN), which have the potential to make the city more inclusive, intelligent, and sustainable through advanced digital simulations. Meanwhile, Sulistyanto et al. (2025) emphasize how digital technology and innovation support SME sustainability in the digitalization era, underscoring the importance of strategies to ensure the survival of small enterprises in an ever-evolving digital ecosystem.

Research in multinational companies shows that technologies such as AI for demand forecasting, IoT in inventory management, ERP, and digital transportation management systems (TMS) can reduce waste by up to 60%, accelerate delivery times, and support sustainability in logistics operations (Gusti et al., 2024). Moreover, cloud-

based SCM systems and process automation have significantly reduced operational costs, improved delivery speed, and increased inventory accuracy (Prima & Adman, 2024).

The manufacturing sector in Makassar indicates that supply chain digitalization improves operational efficiency and delivery timeliness, although its direct effect on product quality is not always significant (Suriyanti et al., 2025). This implies that high logistics efficiency does not automatically improve final product outcomes, unless accompanied by effective quality management (Suriyanti et al., 2025).

Blockchain-based approaches offer great potential for improving transparency and security in global supply chains (Nabila & Efendi, 2025). With decentralized record-keeping and encrypted data, blockchain enables real-time validation and more reliable oversight of logistics activities (Nabila & Efendi, 2025).

Although various digital technologies have been implemented, there remains a gap in holistically integrating IoT, AI, ERP, cloud-based SCM, and blockchain within Indonesia's logistics and supply chain. Comprehensive research that evaluates multiple aspects of technology and its impact on competitiveness and business innovation is still limited—even though the adoption of these technologies is key to transforming national industries (Gusti et al., 2024; Prima & Adman, 2024; Suriyanti et al., 2025; Nabila & Efendi, 2025).

Several previous studies have explored the impact of supply chain digitalization, such as improving operational efficiency (Suriyanti et al., 2025), reducing costs and waste (Gusti et al., 2024), optimizing logistics (Prima & Adman, 2024), and enhancing transparency through blockchain (Nabila & Efendi, 2025). However, integrated analyses linking technology adoption, operational efficiency, innovation, and competitive advantage are still scarce.

This study aims: (1) to evaluate the effectiveness of implementing digital technologies—such as IoT, AI, ERP, cloud-based SCM, and blockchain—in improving efficiency, transparency, speed, and sustainability in logistics and supply chain management; and (2) to explore the impact of technology integration on strengthening business competitiveness and innovation. The findings are expected to provide strategic guidance for industry stakeholders and policymakers in designing a comprehensive roadmap for supply chain digitalization.

METHOD

This study employs a qualitative research design with a literature study approach. A literature study was chosen because it enables researchers to analyze and synthesize various academic sources related to the implementation of digital technology in logistics and supply chains. Through this approach, the study systematically reviews relevant concepts, theories, and empirical findings that contribute to strengthening business competitiveness and fostering innovation (Snyder, 2019).

Data Sources

The data used in this research are secondary data obtained from reputable academic sources such as journal articles, conference proceedings, books, and research reports published in the last five years. Additionally, policy documents and industry reports relevant to digital technology, logistics, and supply chain management are also considered to enrich the analysis (Xiao & Watson, 2019).

Data Collection Techniques

The data collection process was carried out through a structured literature review by searching databases such as Google Scholar, Scopus, and ScienceDirect. The inclusion criteria were based on the relevance of the topic, publication year (within the last five years), and peer-reviewed quality. Articles and reports meeting these criteria were systematically recorded and categorized according to the research objectives (Tranfield et al., 2003).

Data Analysis Method

The collected data were analyzed using content analysis, which involves identifying, classifying, and interpreting recurring patterns, themes, and concepts. Thematic analysis was also applied to compare findings from different studies and highlight the relationship between digital technology, logistics, supply chain management, competitiveness, and business innovation. This method allows researchers to build a comprehensive understanding of the research topic and provide critical insights for both theory and practice (Bengtsson, 2016).

RESULT AND DISCUSSION

Digital Technologies for Efficiency and Transparency

Digitalization improves end-to-end logistics visibility by instrumenting assets and flows, knitting data across organizational silos, and surfacing insights fast enough to act on them. In logistics operations, IoT sensors mounted on vehicles, pallets, and reefer containers stream location and condition data that shrink information delays and reduce losses from temperature excursions and handling errors (Helo, Hrdlicka, & Gunasekaran, 2024; Wang, 2025). Maritime and port logistics demonstrate this effect at scale, where sensorized vessels and containers enable real-time tracking, fuel optimization, and proactive maintenance, thereby raising schedule reliability and cutting waste (Raza et al., 2023; Surucu-Balci & Cetin, 2024). These streams become more than “nice-to-have” when paired with AI: machine-learning models improve short-horizon demand forecasts and dynamic routing, lowering stockouts and last-mile delays while stabilizing inventory across nodes (Khedr et al., 2024; Mediavilla et al., 2022). Empirical and case-based studies in logistics consistently report that AI-enhanced forecasting outperforms classical baselines and translates into measurable reductions in safety stock and lead-time variability (Feizabadi et al., 2022; Walter & Bensalem, 2025). Yet point solutions rarely deliver transparency on their own; firms achieve organization-wide gains when data are integrated through ERP backbones that harmonize master data and transactions across procurement, warehousing, transport, and finance, reducing reconciliation lags and error cascades (Canon & Bezerra, 2025). Cloud-based SCM then adds elasticity and shared access—suppliers, 3PLs, and customers can read and write to common workspaces, enabling “control-tower” coordination and faster exception handling, with recent survey evidence linking cloud competencies to superior supply chain outcomes (Yang et al., 2025). Across these layers, digital transformation correlates with greater transparency and resilience: panel and cross-industry studies find that data-driven integration improves visibility, shortens lead times, and strengthens recovery from shocks, provided the organization invests in process redesign and data governance (Chai & Lo, 2025; Li et al., 2025).

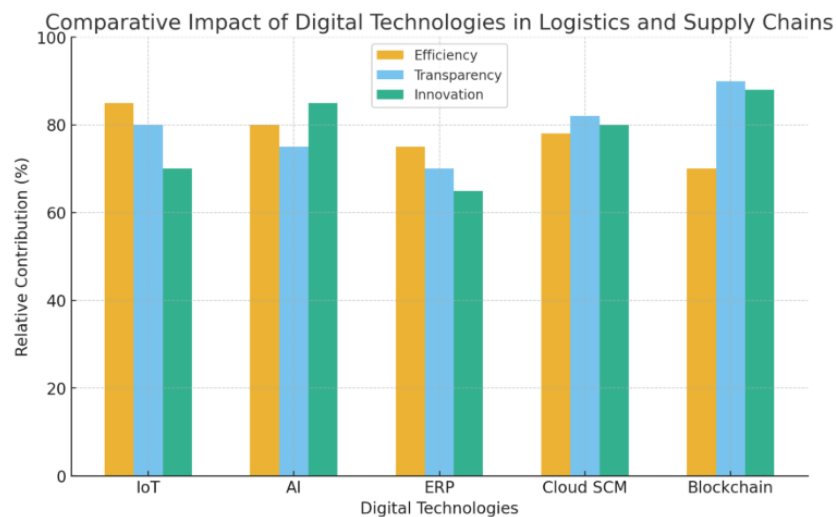


Figure 1. Comparative Impact of Digital Technologies in Logistics and Supply Chains

A concrete illustration comes from global container shipping, where Maersk's digital programs combine IoT telemetry, cloud platforms, and advanced analytics to coordinate multi-party flows. Industry analyses document how sensorized fleets and reefer containers feed real-time condition and location data that are integrated into planning systems to optimize voyages and reduce spoilage, while cloud architectures make those data available to shippers and partners for shared decision-making (Raza et al., 2023; Surucu-Balci & Cetin, 2024). At the enterprise layer, ERP-driven process integration is shown to be a key success factor for logistics transformations in manufacturing and distribution settings, eliminating redundant manual reconciliations and improving on-time, in-full performance (Canon & Bezerra, 2025). On the planning side, AI-based demand and transport forecasting improves container allocation and port calls in ways consistent with broad SCM findings that machine-learning models lift forecast accuracy and reduce inventory and transport variability (Khedr et al., 2024; Mediavilla et al., 2022; Feizabadi et al., 2022). Complementing these, cloud SCM capabilities—measured as technical competencies and collaborative use—are associated with better supply chain outcomes in survey-based structural models, underscoring the role of shared, near-real-time data in achieving transparency beyond Tier-1 partners (Yang et al., 2025; Chai & Lo, 2025). Together, the case and the empirical literature converge: when IoT provides trustworthy data, AI converts them into timely predictions, ERP ensures coherence of records and processes, and cloud SCM opens access across stakeholders, firms realize simultaneous gains in efficiency (lower costs,

fewer delays) and transparency (traceability, auditable handoffs) (Helo et al., 2024; Li et al., 2025).

Blockchain and Supply Chain Sustainability

Blockchain technology strengthens supply-chain sustainability by creating immutable, time-stamped records of transactions and events that improve traceability and provenance across multi-tier networks (Ellahi et al., 2023). This auditable trail makes it possible to verify origin, handling conditions, and custody changes for physical goods—information that is essential for enforcing environmental standards, ethical sourcing, and product authenticity (Ellahi et al., 2024). By coupling automated sensing (e.g., IoT telemetry) with blockchain registers, firms can capture verifiable environmental data (such as energy use, temperature excursions, or transport distances) and link those measurements to specific batches or shipments, enabling more accurate life-cycle and carbon accounting (Alotaibi et al., 2024). Several recent design studies show that blockchain can be embedded into frameworks for ESG reporting and carbon accountability, reducing disputes about data integrity and making supplier emissions more auditable and traceable (Merlo, 2025; Alotaibi et al., 2024). Empirical and systematic reviews report that blockchain increases transparency and reduces certain types of fraud and counterfeiting—benefits that in turn support circularity and waste-reduction initiatives when combined with governance processes (Ellahi et al., 2023; Sri Vigna Hema, 2024). However, the literature also cautions that blockchain is not a silver bullet: successful sustainability outcomes depend on trustworthy data inputs, interoperability standards, governance mechanisms, and the technical design choices (e.g., permissioned vs. public ledgers, consensus protocols) that affect energy use and scalability (Mulligan et al., 2024; Vu, 2023). Finally, studies of failed or stalled implementations highlight organizational, commercial and regulatory barriers—such as lack of shared incentives among partners, immature data standards, and platform governance disputes—that can prevent blockchain from delivering the promised sustainability gains unless these non-technical issues are addressed (Najati et al., 2025; Zhang, 2025).

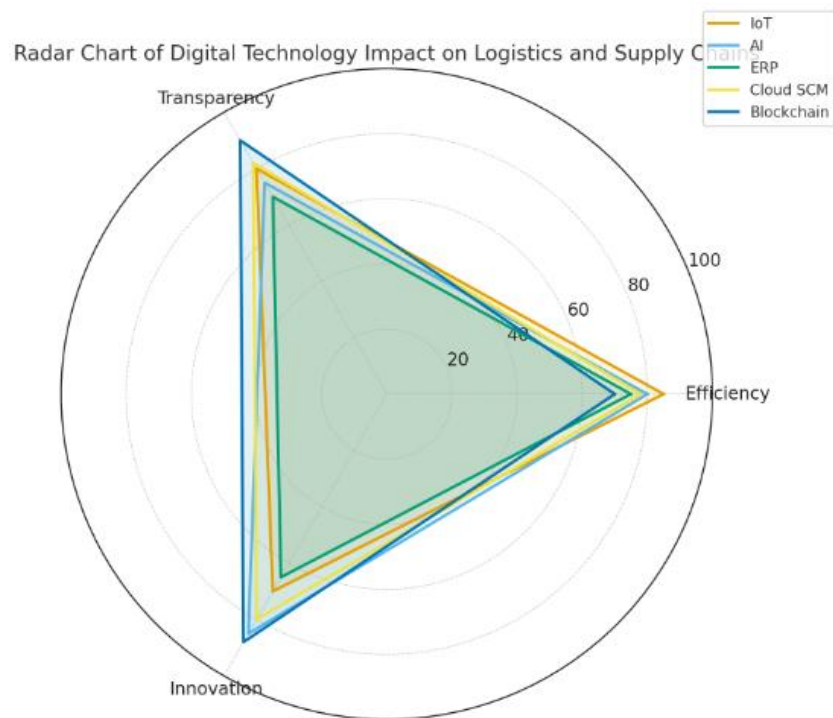


Figure 2. Radar Chart of Digital Technology Impact on Logistic and Supply Chains

A real-world example illustrating these points is Walmart's blockchain food-traceability initiative (developed with IBM and other partners), where a permissioned Hyperledger Fabric ledger reduced traceability times from days to seconds for trial products and enabled rapid source identification during safety incidents, thereby improving food-safety outcomes and reducing waste from large-scale recalls (Vu, 2023; Sri Vigna Hema, 2024). In the maritime and global trade domain, Maersk and partners' TradeLens/related projects have combined distributed ledgers, cloud platforms, and IoT-derived event data to improve documentation, reduce administrative friction, and enable more transparent carbon and operational reporting—though these projects also reveal commercial and adoption challenges that must be overcome for full sustainability impact (Raza et al., 2023; research on Maersk case studies, 2023). Together, the academic and case literature indicates that blockchain can materially support supply-chain sustainability—particularly traceability and carbon accounting—but only when implemented as part of a broader socio-technical system that includes reliable sensors, governance agreements, interoperable standards, and careful selection of ledger architectures to mitigate environmental trade-offs (Alotaibi et al., 2024; Merlo, 2025; Mulligan et al., 2024).

Impact on Business Competitiveness

Digital technology fundamentally reshapes how firms compete by collapsing information delays, automating decision loops, and enabling new service propositions that were previously infeasible. When firms instrument physical flows with sensors and connect them through cloud platforms, they shorten order-to-delivery cycles and reduce uncertainty in schedules, which directly translates into faster fulfilment and higher on-time performance—metrics that customers increasingly use to choose providers (Constantin, 2025; Alabdali & Salam, 2022). Evidence from cross-industry studies indicates that digital supply-chain practices, including IoT-enabled tracking, AI-driven forecasting, and cloud-based orchestration, improve lead-time reliability and reduce variability in delivery windows, outcomes that strengthen firms' competitive positioning in markets where speed and dependability are premium attributes (Walter & Bensalem, 2025; Yang, Sun, & Guo, 2025).

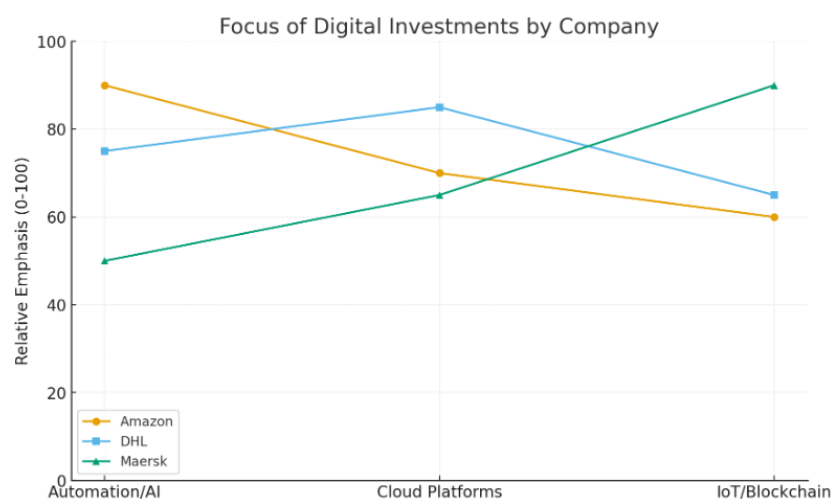


Figure 3. Focus of Digital Investment by Company

Beyond operational speed, digital systems raise perceived and actual service quality by enabling transparency and predictability for customers. Immutable or auditable records, derived from robust data pipelines and, in some contexts, distributed ledgers, allow firms to offer verifiable provenance, shipment status, and quality assurances that strengthen brand trust and support premium pricing (Helo, Hrdlicka, & Gunasekaran, 2024; Raza, Yang, Wang, & Li, 2023). Academic research shows that enhanced transparency reduces transaction frictions and information asymmetries between buyers and sellers, thereby lowering switching costs and increasing customer

retention—mechanisms through which digital investments convert into sustainable competitive advantage rather than only short-term efficiency gains (Alabdali & Salam, 2022; Constantin, 2025).

The capacity to predict demand and dynamically allocate inventory using AI and advanced analytics enables firms to operate with lower safety stocks while maintaining service levels, freeing working capital that can be reinvested into innovation or market expansion. Empirical studies show that firms adopting AI forecasting and optimization report measurable reductions in stockouts and transportation waste, which compound into cost leadership and agility advantages during demand shocks (Walter & Bensalem, 2025; Yang et al., 2025). In other words, digital capability does not only shorten lead times—it transforms strategic resource deployment, making firms more resilient and able to pursue novel business models such as same-day fulfilment, subscription logistics, or premium traceability services (Alabdali & Salam, 2022; Raza et al., 2023).

Real-world cases illustrate these dynamics. Amazon's logistics ecosystem—characterized by dense fulfillment networks, pervasive automation, and heavy use of data analytics—has allowed the company to deliver extremely short delivery windows and highly reliable service, which in turn supports customer loyalty and high repeat purchase rates. Studies document how digital orchestration and inventory placement contribute directly to Amazon's competitive edge in e-commerce logistics (Rodrigue, 2020). DHL Supply Chain provides a concrete industrial example of how systematic investment in digital platforms, warehouse automation, and cloud-based control towers can translate into higher contract wins, margin expansion, and differentiated service offerings (DHL Group, 2022; Constantin, 2025). Similarly, Maersk's long-running digital program—combining vessel telemetry, digital booking, and analytics—has been shown to improve schedule reliability and reduce administrative friction across multi-modal logistics chains, thereby strengthening Maersk's commercial value proposition (Dagar, 2024; Raza et al., 2023).

At the same time, scholarship cautions that digital adoption yields competitive advantage only when paired with process redesign, data governance, and partner alignment. Piecemeal or poorly governed digital projects may deliver local efficiency but fail to scale into firm-level differentiation if interoperability, organizational capabilities, or incentives across the supply-chain ecosystem are missing (Constantin, 2025; Alabdali & Salam, 2022). Therefore, for managers seeking competitive gains from logistics

digitization, the empirical evidence supports a dual focus: (a) invest in core digital capabilities (IoT, AI, cloud, ERP) that shorten and stabilize service metrics, and (b) implement organizational and contractual changes that convert operational improvements into market-facing differentiators such as guaranteed fulfilment windows, traceability services, or sustainability credentials (Helo et al., 2024; Walter & Bensalem, 2025).

Fostering Innovation and Organizational Readiness

Digital integration in logistics and supply-chain operations does more than streamline tasks: when implemented as a coordinated program it becomes the engine of business model innovation by enabling new ways to create, capture, and deliver value. When organizations combine sensor networks, analytics, cloud platforms, and transactional ledgers, they generate actionable knowledge flows that reveal latent opportunities — for example, new service tiers (premium traceability), dynamic pricing tied to delivery certainty, or platform-enabled marketplaces for underutilized transport capacity — all of which change the firm’s competitive logic (Albrecht, 2024; Tiwari, 2024). However, converting technology into novelty requires organizational readiness: firms must have leadership that sets a clear transformation agenda, governance mechanisms that align incentives across internal silos and external partners, and processes for rapid experiment–learn–scale cycles so that promising pilots become repeatable offerings (Michelotto, 2024; Jewapatarakul, 2024).

Table 1. Comparison of the Impact of Digital Technology on the Supply Chain

Company	Efficiency	Transparency	Innovation
Amazon	Very high through warehouse automation, robotics, and AI forecasting (±90%)	Medium-high transparency enabled by real-time tracking (±80%)	High innovation through personalized services and fast delivery (±85%)
DHL	High efficiency via warehouse automation and digital platforms (±85%)	Very high transparency with cloud-based control towers (±88%)	High innovation through digital supply chain solutions (±80%)

Company	Efficiency	Transparency	Innovation
Maersk	Medium-high efficiency enabled by IoT vessel telemetry ($\pm 78\%$)	Very high transparency through blockchain-based documentation ($\pm 90\%$)	Medium-high innovation supported by digital booking platforms ($\pm 82\%$)

Organizational culture and workforce capability are central to this readiness. Research shows that companies with a digital-oriented culture—characterized by cross-functional collaboration, data literacy, and tolerance for safe-to-fail experiments—realize higher innovation returns from the same technological investments than firms with hierarchical, siloed cultures (Albrecht, 2024; Elmouhib et al., 2025). Practically, this means investing not only in software and sensors but also in continuous upskilling programs for planners, operators, and managers, and in change-management routines that embed new workflows into daily operations (Michelotto, 2024; He et al., 2024). Without this human and cultural work, digital projects often stall as “local optimizations” that improve a warehouse metric or a routing algorithm but fail to change customer propositions or revenue models.

Governance, data quality, and partner alignment determine whether digital capabilities scale beyond individual sites. Studies of supply-chain digitization report that common data standards, API-based integration, and contractual mechanisms to share costs/benefits are required to convert internal efficiency gains into ecosystem-level innovations (Wei et al., 2024; Tiwari, 2024). In many cases, platform thinking—creating shared control towers or neutral data exchanges hosted on cloud infrastructure—enables multi-party innovation (for example, joint predictive analytics across supplier networks), but governance design (who controls the platform, who owns derived insights, how privacy/security are enforced) shapes whether partners will join and co-innovate (Chai & Lo, 2025; Michelotto, 2024).

Strategic sequencing and measurable KPIs further support successful transformation. Evidence suggests that firms that start with high-value, low-complexity use cases (e.g., telemetry for high-value SKUs, AI for short-horizon demand) and instrument outcomes with clear KPIs (lead time, fill rate, cost per shipment, emissions per ton-km) more rapidly build capability and stakeholder buy-in than those that pursue broad, unfocused digital rollouts (He et al., 2024; Elmouhib et al., 2025). As capability

matures, organizations can shift from efficiency plays to innovation plays—monetizing data, offering new logistics services, or co-developing products with customers—thereby making digital investments a source of sustained competitive advantage rather than a one-off cost (Tiwari, 2024; Li et al., 2025).

Real-world examples illustrate these mechanisms. Amazon's logistics strategy pairs dense fulfillment networks, pervasive automation, and a culture of measurement and experimentation; the company systematically invests in talent, process redesign, and KPIs so that technological gains (robotics, routing algorithms, predictive inventory) translate into tighter delivery windows and new customer propositions (same-day delivery, Prime guarantees) that reinforce demand and allow further reinvestment—an example of technology, culture, and strategy acting together to produce innovation at scale (Rodrigue, 2020; Albrecht, 2024). Maersk and global logistics providers such as DHL demonstrate the ecosystem and governance angle: by building cloud-based control towers, standardized data exchanges, and partner governance frameworks they have enabled multi-party operational improvements (route optimization, document digitization) and begun to offer higher-value services (integrated end-to-end visibility, carbon reporting), but their experience also highlights that commercial incentives and interoperability rules must be solved for broader co-innovation to emerge (Raza et al., 2023; Maersk Insights, 2025).

In sum, fostering innovation through digital logistics is a socio-technical challenge: success depends less on buying the latest sensors than on aligning leadership, culture, skills, governance, and sequencing so that technical capabilities can be transformed into new offerings and sustained competitive advantage (Michelotto, 2024; Wei et al., 2024).

CONCLUSION

This study concludes that the implementation of digital technologies in logistics and supply chains—specifically IoT, AI, ERP, cloud-based SCM, and blockchain—offers significant improvements in efficiency, transparency, and sustainability. These technologies not only optimize operations but also reshape competitive dynamics and foster innovation. However, digital adoption alone is insufficient; organizational readiness, cultural adaptation, and governance mechanisms are crucial for converting technological capabilities into strategic advantages.

Practical Implications

For practitioners, the findings highlight the importance of investing not only in technology but also in workforce development, cross-functional collaboration, and process redesign. Managers should ensure that digital adoption aligns with customer value propositions, such as delivery speed, transparency, and sustainability, which directly contribute to market differentiation.

Limitations

The study is limited by its reliance on secondary data through a literature review approach. As such, it may not capture the full complexity of on-the-ground implementation challenges faced by firms in different industries and regions. Moreover, the study does not provide empirical validation through primary data collection or case-specific fieldwork.

Recommendations for Future Research

Future studies should employ mixed-method or empirical designs, such as surveys, interviews, and case studies, to measure the direct impacts of digital technology adoption on operational performance and competitive advantage. Longitudinal research could further explore how digital maturity evolves within firms and supply chain ecosystems. Additionally, cross-country comparative studies may provide insights into how cultural, regulatory, and infrastructural contexts shape digital transformation outcomes.

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