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Charting the Evolution of Information Systems in Supply Chain Management: A Narrative Review of Three Competitive Eras

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A B S T R A C T

The strategic role of Information Systems (IS) in supply chain competitiveness (SCC) has undergone a profound, yet inadequately synthesized evolution. This narrative review addresses this gap by proposing a 3-era framework that charts the coevolution of IS and SCC, revealing a fundamental paradigm shift in competitive logic. The analysis identifies: (1) the Internal Efficiency Era, where IS established cost leadership through automation and intra-firm integration (e.g., ERP and MRP); (2) the Inter-Organizational Coordination Era, where digital connectivity redefined advantage as dyadic reliability, enabling practices like VMI and CPFR (e.g., via EDI, RFID; (3) the Network-Wide Intelligence Era, where converging technologies (e.g., AI, IoT, and blockchain) are fostering ecosystem-wide resilience and adaptive decision-making. The review contributes a coherent conceptual framework that argues IS has progressively reconfigured the source of competitive advantage. This synthesis provides scholars and practitioners with a robust lens for understanding the historical progression and future trajectory of digitally driven supply chains.

1. Introduction

The pursuit of sustainable competitive advantages has consistently positioned effective Supply Chain Management (SCM) as a critical strategic imperative (HUANG et al., 2015). In an era defined by rising customer expectations, and global connection, the capability to orchestrate seamless flows of materials, information, and capital across a network is a fundamental determinant of organizational performance (SANDERS, 2016). Central to this capability is the strategic deployment of Information Systems (IS), which acts as the core of the modern supply chain, enabling the coordination, agility, and visibility required for competitive success (DEHGANI and JAFARI NAVIMIPOUR, 2019).

A substantial body of academic work has established the foundational links between information technology and supply chain outcomes. Seminal research demonstrates that IS integration drives operational efficiency through shorter cycle times, lower inventories, and reduced distortion (BAGCHI and SKJOETT-LARSEN, 2003). Subsequent investigations have detailed the competitive implications of specific technologies, from Electronic Data Interchange (EDI) for transactional efficiency to Enterprise Resource Planning (ERP) for internal process integration (GUNASEKARAN and NGAI, 2004; MATENDE and OGAO, 2013). This confirms that IS are not only supportive tools but are deeply embedded in the architecture of Supply Chain Competitiveness (SCC).

However, while the value of discrete technologies is well documented, the literature is often segmented by specific systems, time periods, or functional perspectives. What remains less synthesized is a longitudinal narrative that explains the evolutionary progression of the IS-SCM relationship. This review uniquely integrates a strategic management lens to argue that each

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technological phase fundamentally reconfigures the source of competitive advantage itself. This gap limits holistic understanding of the field's trajectory and the strategic implications of current technological convergence. To address this gap, this paper presents a narrative review that deploys a 3-era conceptual framework to chart the co-evolution of IS and SSC. It is proposed that this evolution can be characterized by three distinct paradigms: (1) The Internal Efficiency era, focused on cost leadership through automation; (2) the Inter-organizational Coordination era, focused on reliability through dyadic integration; (3) the Network-Wide intelligence era, focused on resilience and adaptation through predictive, cognitive systems. By constructing this framework, this review synthesizes a broad body of work to argue that IS have progressively transformed SCC from a focus on internal cost control to a dynamic capability rooted in networked intelligence and strategic adaptability (BESKE, 2012). The remainder of this paper is structured as follows. Section 2 details the narrative review methodology employed. Section 3 is the results and discussion where section 4 presents the limitations, recommendations, and conclusion.

2. Review Methodology and Scope

This paper employs a narrative review methodology to synthesize and interpret the scholarly literature. Its objective is to construct a coherent framework that traces the historical and thematic evolution of Information Systems (IS) within Supply Chain Management (SCM), specifically assessing their shifting role in shaping competitive advantage. Narrative reviews are recognized for their utility in integrating diverse perspectives, identifying overarching trends, and developing conceptual models from a broad collection of literature (BAUMEISTER and LEARY, 1997). This approach is particularly suited for mapping a longitudinal progression of ideas and technological paradigms.

To establish an appropriate foundation for this synthesis, a structured, multi-phase process for literature identification and analysis was followed. Initial exploratory searches were conducted in academic databases (WILES, CROW, & PAIN, 2011), including Emerald and ScienceDirect, by targeting utilized iterative keyword strings combining core concepts: information systems (e.g., ”AI”, ”ERP, ”EDI”, ”IoT”), supply chain constructs (e.g., ”SCM”, ”logistics”), and performance outcomes (e.g., ”competitiveness”, ”agility”, ”resilience”, ”performance”).

The selection of literature which was guided by principles of purposive sampling and conceptual relevance rather than exhaustive retrieval (CAMPBELL et al., 2020). the goal is to achieve thematic saturation by identifying seminal and influential works that defines key technological shifts and strategic conversations. The scope-defining criteria presented in (Table 1) serves as a flexible examination to ensure selected works directly contributed to understanding the IS-SCM-competitiveness nexus.

Table 1: Scope-Defining Criteria for Literature Selection.

Focus Area	Scope of Review	Out of Scope
Subject of study	Studies focusing on the relationship, impact, or role of IS or IT on SC performance, capabilities, or competitiveness	Studies focused on IS/IT in a single enterprise without a supply chain context (e.g., standalone manufacturing execution systems) or studies on supply chains that do not address an IS/IT component
Type of Information System	Any type of IS/IT, including but not limited to: ERP, EDI, WMS, TMS, RFID, IoT, AI/ML, Blockchain, and Cloud Computing	Physical technologies or hardware (e.g., automated guided vehicles, robotics) where the IS component is not the primary focus of analysis.
Outcome Measure	Studies that measure, discuss, or theorize about a dimension of	Studies where the primary outcome is not related to SCC

	SCC or performance, such as cost, efficiency, reliability, responsiveness, resilience, agility, integration, or collaboration.	(e.g., IS implementation success factor, user adoption of technology where performance is not measured)
Language and Time Frame	Articles written in English and between the years 1980-2025	Non-English articles and articles outside the time frame
Data Availability and Publication Type	Studies where the full text was accessible. Peer-reviewed academic journal articles and conference proceedings	Studies where the full text could not be obtained. Books, book chapters, editorials, news articles, and non-peer-reviewed working papers.

Source: Author's own work

The initial search and screening, yielded a broad set of over 700 publications. From this set, a final number of 33 studies were identified for analysis as illustrated in the flow chart (Figure 1). The analytical process was iterative and interpretive. The selected literature was organized chronologically to reveal any underlying patterns, then through thematic analysis, several themes have been identified.

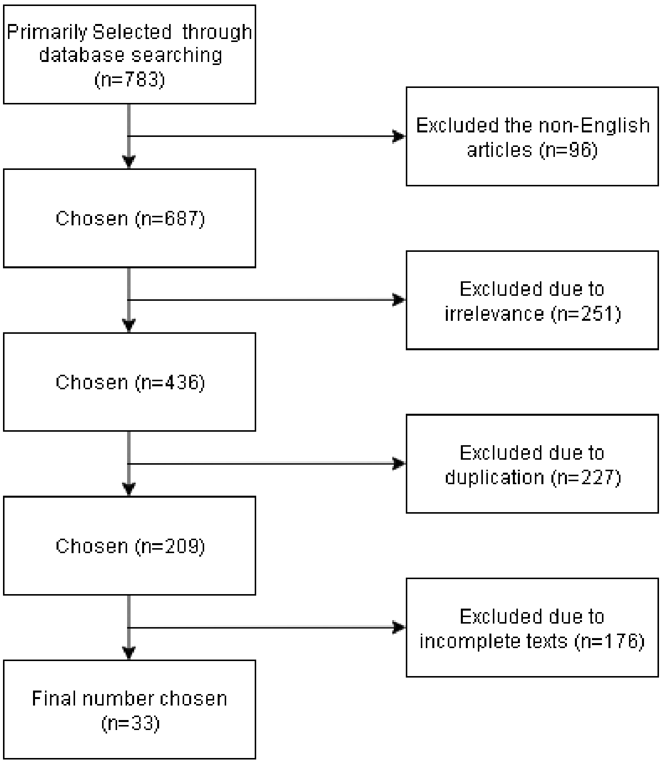

Figure 1: Literature Search and Screening Flowchart (source: Author's own work)

3. Results and Discussion

The primary objective of this study was to systematically identify, evaluate, and synthesize scholarly evidence related to the evolving impact of information systems on supply chain competitiveness. The analysis of the selected literature reveals a clear and compelling evolutionary narrative. This chapter presents the core findings of this review, organized around three distinct eras that characterize this evolution: 1) the Internal Efficiency era, 2) the Inter-Organizational Coordination era, and 3) the Network-Wide Intelligence era.

3.1. Era 1: The Internal Efficiency Era (Late 1970s – Mid 1990s): Foundations of Cost Leadership

The analysis identifies a foundational period where the strategic application of IS was primarily introspective, aimed at mastering internal operations. This era is defined by a paradigm of internal optimization, where competitiveness was identified with cost leadership achieved through the automation and integration of intra-firm processes. The scholarly consensus positions technology as a lever to optimize the firm's value chain, with its strategic worth derived from enhancing the efficiency of primary and support activities (WALTERS and LANCASTER, 2000). Consequently, IS investments were justified almost exclusively through metrics of cost reduction, labor productivity, and asset utilization (HITT, WU & ZHOU, 2002).

Dominant Technologies and Architectural Integration

The technological landscape was architected for data centralization and process automation within firm boundaries. The evolution began with Material Requirements Planning (MRP), which computerized production scheduling to translate master plans into precise material orders (PLENERT, 1999). This logic expanded into Manufacturing Resource Planning (MRP II), creating a more comprehensive closed loop system. The apex of this internal focus was the rise of Enterprise Resource Planning (ERP) systems, which aimed to dismantle functional silos by integrating finance, human resource, manufacturing, and distribution into a unified database, establishing a definitive "single source of truth" (MARNEWICK and LABUSCHAGNE, 2005). Complementing these integrated platforms, specialized systems like Warehouse Management Systems (WMS) and Computer-Aided Design (CAD) automated discrete functions, contributing localized efficiencies that fed the overarching goal of organizational cost reduction (DELONE, 1998).

Impact on Supply Chain Competitiveness: The Primacy of Cost

The impact of these technologies fundamentally reconfigured the internal drivers of competitiveness. The primary mechanism was a transformation in cost control, shifting from localized thrift to systemic optimization of working capital and operational expenditure. Centralized data architectures, primarily through ERP, enabled dramatic improvements in inventory management, leading to lower safety stock levels, higher inventory turnover, and reduced carrying cost (MCAFEE, 2002). Furthermore, the automation of manual and administrative tasks significantly increased labor and asset productivity while minimizing human error, directly boosting operational margins (SWAMIDASS, 2007). The integration of disparate departments also enhanced internal coordination, shortening cycle times and improving scheduling accuracy, which further drove down operational costs (GATTIKER and GOODHUE, 2005). Thus, in this era, SCC was intrinsically linked to the ability of IS to render internal processes lean, visible, and efficient. However, this internal optimization often resulted in rigid, monolithic systems that later posed significant challenges for integration with external partners.

3.2. Era 2: The Inter-Organizational Coordination Era (Early 1990s – Late 2010s): The Rise of Reliability through Dyadic Integration

The review highlights a major paradigm shift beginning in the early 1990s, where the position of value creation moved beyond the boundaries of the single firm. As companies mastered internal efficiencies, the next source of competitive advantage was identified in the electronic integration and coordination with external partners (WILLIAMS et al., 2013). This era was driven by the commercialization of the internet, which provided a universal and standardized platform for connectivity, overcoming the significant cost and technical barriers of earlier corrective networks (ZHU, 2004). The strategic focus evolved from optimizing internal cost to enhancing reliability, responsiveness, and service quality across dyadic relationships. Information Systems in this period were thus characterized by their core functions of enabling secure and structured information exchange between legally independent but operationally interdependent organizations (RAI, PATNAYAKUNI & SETH, 2006).

Dominant Technologies: Enabling Electronic Handshakes

The technologies that defined this era were engineered to bridge organizational gaps. Electronic Data Interchange (EDI), saw wider adoption as standards solidified, enabling the direct, application to application exchange of structured business documents, thereby eliminating manual re-entry and its associated delays and errors (LEE and LIM, 2003). The internet enabled more flexible web-based enterprise portals and extranets, offering partners user-friendly access to shared data like inventory levels and order status. SCM and advanced Planning and Scheduling (APS) software modules evolved as extensions to core ERP systems, using integrated internal data to facilitate synchronized planning and execution across partner networks (STADTLER, 2005). A significant leap in visibility came with Radio-Frequency Identification (RFID), which moved beyond static barcodes to enable real-time, automatic tracking of goods as they moved through the supply chain, providing unprecedented transparency into shipment status and location (WHITAKER, MITHAS & KRISHNAN, 2007).

Impact on Supply Chain Competitiveness: Redefining Advantage as Reliability

The implementation of these inter-organizational systems led to a clear evolution in the metrics for supply chain competitiveness. While cost remained important, the primary competitive benefits shifted towards enhanced reliability and partnership performance. The automation of document flows via EDI and portals reduced transactional errors and cycle times, resulting in measurable improvements in critical performance indicators like On-Time-In-Full (OTIF) delivery rates (RAI, PATNAYAKUNI & SETH, 2006). The visibility from portals and RFID enabled a more responsive supply chain, allowing firms to react more swiftly to changes in demand or supply shifts, which reduce lead times and boosting customer satisfaction (ZHU, 2004). The trusted data exchange enabled by these information systems became the essential foundation for new collaborative practices in this era, like Vendor-Managed Inventory (VMI) and Collaborative Planning, Forecasting, and Replenishment (CPFR). These practices redefined competitiveness, shifting the focus from the performance of a single entity to the combined performance of supply chain partnerships, establishing operational reliability and trust as tangible competitive assets (WILLIAMS et al., 2013). Furthermore, the high cost and technical complexity of solutions like EDI could create barriers to entry for smaller suppliers, potentially limiting the depth of network integration.

3.3. Era 3: The Network-Wide Intelligence Era (Mid 2010s - Present): Cognitive Ecosystems and Adaptive Advantage

The current evolutionary era represents a fundamental shift from digital connectivity to cognitive supply chains. This era is not only an extension of the previous one but a paradigmatic shift from reactive integration to predictive, autonomous intelligence (IVANOV, 2023). While Era 2 established electronic linkages between partners, Era 3 leverages these connections through massive data aggregation, advanced analytics, and machine-driven decision-making to create a self optimizing network. This shift is fueled by the convergence of several technological revolutions: the pervasive sensing of the Internet of Things (IoT), the high speed low-latency connectivity of 5G, the elastic computational power of cloud platforms, and the sophisticated pattern recognition of Artificial Intelligence (AI). In this intelligent ecosystem, competitiveness is being radically redefined, moving beyond efficiency and reliability toward predictive resilience, autonomous adaptation, and value co-creation (WAMBA et al., 2020). Modern supply chains are thus evolving from linear, sequential pipelines into dynamic, self-adjusting networks where IS functions not only as tools for execution but as platforms for strategic innovation (BEN-DAYA et al., 2023).

Dominant Technologies: The Architecture of Intelligence

The technological foundation of this era is architected for real-time data ingestion, processing, and action. The IoT forms the distributed sensory network, embedding intelligence into physical assets to generate continuous, granular data streams on status, location, and performance (BOUSDEKIS et al., 2023). Cloud Computing provides the indispensable, scalable infrastructure to store and process this exponentially growing data. The core cognitive capability is delivered by Artificial Intelligence and Machine Learning (AI/ML) algorithms, which analyze structured data from ERP and IoT sensors alongside unstructured external data to identify complex patterns, predict disruptions, and prescribe optimal responses (IVANOV, DOLGUI, & SOKOLOV, 2019; THAYYIB et al., 2023). Furthermore, Blockchain technology is emerging as a foundational layer for trust in decentralized networks, creating secure, transparent, and immutable distributed registers. This enables verifiable provenance tracking and automated smart contracts, potentially revolutionizing areas like ethical sourcing, counterfeit prevention, and multi-party compliance (SEZER et al., 2023; KSHETRI, 2018).

Impact on Supply Chain Competitiveness: The New Logic of Resilience and Innovation

The capabilities of these intelligent systems have fundamentally transformed the benchmarks for supply chain competitiveness. The primary focus has expanded to building organizational resilience and adaptive agility in an increasingly volatile global environment. AI-powered predictive analytics enable a decisive move from reactive problem-solving to proactive risk management, allowing firms to forecast potential disruptions and simulate mitigation strategies before materializing (BARYANNIS et al., 2019). This predictive capability also derives unprecedented efficiency through dynamic, autonomous optimization (GUPTA et al., 2020).

Moreover, this era enables a unique data-driven customer-centricity and sustainable innovation. End-to-end visibility and analytics allow for mass customization and personalized consumer experience, turning flexibility into a direct market differentiator (TU, 2018). Simultaneously, technologies like blockchain provide auditable, immutable proof of sustainable and ethical sourcing practices, transforming supply chain transparency from a compliance cost into a powerful brand asset and competitive channel. These advances, however, introduce new dependencies on data quality, algorithmic governance, and cybersecurity, raising critical questions about liability, ethics, and the potential for new forms of risk. In essence, competitiveness in this era, is defined by a supply chain's cognitive capacity, which is its ability to learn from data, adapt to change, and to innovate at the speed of the network itself.

4. Discussion and Conclusion

4.1 Synthesis and Theoretical Contribution

This narrative review has synthesized the scholarly discourse to propose a 3-era framework charting the co-evolution of IS and SCC. The progression from Internal Efficiency to Inter-Organizational Coordination and finally to Network-Wide Intelligence lays out a paradigm shift in the strategic logic governing IS deployment. It initially derived from the optimization of internal, firm-specific resources, and advantage has progressively migrated to the inter-organizational era, reliant on relational rents generated through dyadic integration (LAVIE, 2006). It is now increasingly predicated on dynamic capabilities rooted in data, analytics, and network-wide cognitive processes (WARNER and WÄGER, 2019).

Furthermore, the framework illuminates the changing nature of integration itself. In era 1, integration was processual and internal, focused on data consistency across functions. In era 2, it became transactional and dyadic, focused on seamless electronic exchange with partners. In era 3, integration is becoming cognitive and eco-systemic, characterized by the fusion of data streams and predictive intelligence across a multi-actor network. This evolution underscores a critical insight: the challenge of integration has consistently been a primary bottleneck to realizing the next frontier of competitiveness, and each era's dominant technologies represents a solution to the integration limitations of the previous one.

4.2 Practical Implications

The evolutionary framework developed in this review carries significant implications for supply chain executives, technology strategists, and organizational leaders navigating digital transformation. First, it provides a diagnostic lens for strategic investment. Managers can assess their organization's current dominant IS paradigm and evaluate whether their technology portfolio aligns with their targeted competitive priorities (REINARTZ, WIEGAND, & IMSCHLOSS, 2019). Investments in advanced analytics (era 3) will yield limited strategic returns if fundamental internal data integration (era 1) or trusted partner connectivity (era 2) are not mature. The framework argues for a sequential, capability-building approach where foundational integration enables advanced intelligence.

Second, the framework highlights that competitive advantage is increasingly relational and systemic. The shift from internal efficiency to network-wide intelligence means that a firm's competitiveness is now inextricably linked to the data capabilities and digital maturity of its partners. Leaders must therefore develop competencies in ecosystem governance, data-sharing agreements, and collaborative innovation to capture value in the intelligent era (HEIN et al., 2020). Finally, the evolution underscores a critical shift in the required organizational mindset and talent. Moving from automation to coordination to cognitive prediction demands a parallel evolution from operational and IT specialists to data scientists, AI ethicists, and ecosystem orchestraters (FRANK et al., 2019). The primary managerial challenge is no longer just implementing technology, but fostering an organizational culture that embraces data-driven experimentation, algorithmic decision-making, and continuous adaptation.

4.3 Limitations

While this narrative review provides a conceptual framework, its methodological choices and scope inherently define its boundaries. First, the review is interpretive rather than exhaustive. As a narrative synthesis, it prioritizes conceptual development and thematic saturation over the comprehensive, protocol-driven retrieval characteristics of systematic reviews (BAUMEISTER and LEARY, 1997). Consequently, while it captures influential and representative scholarship that defines the field's evolution, it does not claim to include every relevant publication, which may exclude some secondary viewpoints.

Second, the proposed 3-era framework, simplifies a complex and non-linear reality. Technological adoption is heterogeneous across industries and firm sizes (PARÉ et al., 2015), and the boundaries between eras are permeable, with legacy systems persisting alongside cutting-edge innovations. The framework's strength in providing a clear archetypal narrative is thus also a limitation, as it may understate the concurrent, overlapping co-existence of different technological paradigms within a single supply network. Finally, the rapid velocity of technological change in domains like generative AI and next-generation IoT presents a challenge common to all scholarly reviews (CHUBB, COWLING, & REED, 2022). The literature base, particularly in peer-reviewed journals, inherently lags behind the most recent industry developments. Therefore, while the network-wide intelligence era captures a prevailing direction, its specific technological design is continuously evolving, and the framework will require periodic reassessment to maintain its explanatory relevance.

4.4 Future Research Directions

First, research must address the tension and integration pathways between technological eras. An example might be, is how organizations architect hybrid systems that effectively bridge ERP infrastructures (era 1) with intelligent, cloud-native platforms (era 3). Studies investigating middleware strategies, data governance in hybrid environments, and the change management required for such transitions are needed (BAIYERE, SALMELA & TAPANAINEN, 2020).

Second, as the locus of competition shifts to the network, new metrics and assessment models for ecosystem wide performance must be developed. Traditional, firm-centric key performance indicators (KPIs) are inadequate for measuring the resilience, innovation capacity, and shared value creation of intelligent supply networks (BÜYÜKÖZKAN and GÖÇER, 2018). Future work should propose and validate multi-tier performance frameworks that capture the health and intelligence of the entire ecosystem. Finally, the ascendancy of AI and autonomous decision-making in era 3 raises profound ethical, governance and strategic questions. Research is needed on algorithmic accountability in supply chain decisions, the distribution of risks and rewards in data-sharing partnerships, and the strategic implications of relinquishing operational control to cognitive systems. Exploring these themes will ensure that the evolution toward intelligent supply chains is both effective and responsible.

4.5 Concluding Remarks

This review has articulated that the relationship between IS and SCC is not static, rather evolutionary. For scholars and practitioners, the imperative is to view IS not as a series of discrete tools, but as the evolving architecture of competitive advantage. The source of that advantage has progressively migrated from within the firm to the spaces between firms, and now resides in the quality of intelligence that flows across the entire network. As supply chains continue their transformation into predictive and adaptive systems, the frameworks used to understand them must be equally dynamic. This review offers one such setting, arguing that in an age of disruption, the most sustainable competitive advantage may ultimately be a supply chain's inherent capacity to learn, reinterpret, and intelligently evolve.

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