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Digital Procurement in Clinical Research: Tools, Governance, and Future Trends for Vendor Management and Process Harmonisation

Gourab Ray *

School of Computer Science, Indira Gandhi National Open University (IGNOU), New Delhi, India.

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Abstract

Procurement in clinical research is increasingly orchestrated through complex vendor ecosystems contract research organizations (CROs), central laboratories, eClinical technology providers, and specialty logistics partners whose performance directly shapes cost, cycle time, quality, and inspection readiness. Digital procurement (e-procurement/source-to-pay [S2P] platforms, contract-lifecycle management [CLM], supplier relationship and vendor performance management [SRM/VPM], robotic process automation [RPA], artificial intelligence and machine learning [AI/ML], and blockchain) promises to transform vendor management while harmonising processes across sites and geographies. We conducted a PRISMA-guided review (2018–2025) of peer-reviewed literature spanning supply-chain management, information systems, operations, and healthcare journals. Twenty-one studies met inclusion criteria. Convergent evidence shows that integrated e-procurement/S2P and CLM/SRM/VPM suites can reduce cycle times, enhance transparency and compliance, and provide the data substrate for KPI-driven oversight; however, value is contingent on data stewardship, integration quality, and operating-model change. AI/ML increasingly supports supplier-risk sensing and predictive governance; deep-learning approaches in particular have demonstrated superior predictive accuracy in critical industries, extending the broader roles of AI identified in procurement. When RPA follows business-process-management (BPM)-led redesign, quasi-experimental evidence documents meaningful reductions in manual workload and procurement cycle time, while complementary work frames RPA as a strategic capability that must be governed and maintained to scale. Blockchain shows promise for traceability and anti-counterfeit in healthcare and pharmaceutical supply chains, yet empirical, at-scale deployments in clinical-trial settings remain limited, with performance and governance challenges to overcome. A dynamic-capabilities lens clarifies why tools alone do not harmonise processes: sensing, seizing, and reconfiguring capabilities are prerequisites for sustained impact. We conclude with a practical blueprint for clinical procurement leaders and a research agenda calling for controlled, life-sciences-specific outcome studies linking digital procurement to milestones such as time-to-site activation, first-patient-in, and audit findings.

Keywords: Clinical Research; Procurement; E-Procurement; Vendor Management; Process Harmonisation; AI/ML; RPA; Blockchain; Dynamic Capabilities; PRISMA

1. Introduction

Modern clinical development depends on a distributed network of specialised vendors. Sponsors outsource study execution to CROs; assay and biomarker work to central laboratories; platform operations to interactive response technology (IRT), randomisation and trial-supply management (RTSM), and electronic data capture (EDC) providers; and logistics for investigational medicinal product (IMP) to temperature-controlled carriers and depots. This networked model expands capacity and expertise but also introduces variability in process execution, fragmented information flows, cumulative compliance risk, and limited visibility into performance and total cost of ownership.

* Corresponding author: Gourab Ray; ORCID: 0000-0002-4682-8925

Across sectors, the scholarly literature recognises that digital procurement—the integration of end-to-end source-to-pay (S2P) platforms with analytics, automation, and algorithmic decision support—can shift procurement from a transactional cost function toward a strategic, data-driven orchestrator of supplier ecosystems (Herold et al., 2023; Mavidis and Folinas, 2022). Reviews of Procurement/Industry 4.0 technologies highlight the growing centrality of e-procurement, AI/ML, and blockchain for efficiency, risk management, and transparency, while repeatedly cautioning that integration quality and data governance mediate the value realised (Althabatah et al., 2023; Mavidis and Folinas, 2022). In this perspective, procurement becomes not only a gatekeeper of spend, but a platform for harmonisation, encoding standards, templates, and governance into everyday workflows and data structures.

In life sciences, the imperative is sharpened by multi-site, multiregional study designs and heightened regulatory expectations for oversight and data integrity. While clinical-trial–specific procurement studies remain relatively sparse, adjacent peer-reviewed research in healthcare operations and supply chains offers mechanisms applicable to clinical procurement. For example, hospital-supply chain reviews identify comprehensive KPI families and link them to service and audit readiness, providing a transferable template for CRO and vendor oversight (Fallahnezhad et al., 2024). Supply-chain resilience reviews emphasise digital twins and machine learning for real-time sensing and risk mitigation (Hosseini Shekarabi et al., 2025; Zogaan et al., 2025). Blockchain reviews in healthcare and pharmaceutical contexts synthesise use cases, barriers, and conceptual frameworks for implementation (Fiore et al., 2023; Ghadge et al., 2023; Kasyapa and Vanmathi, 2024).

This review has three objectives. First, to synthesise peer-reviewed evidence on digital tools that enable vendor management and process harmonisation in procurement. Second, to map these tools to governance structures and organisational capabilities pertinent to clinical research. Third, to identify future trends and research needs that would strengthen the evidence base and inform practice in regulated settings. We apply the dynamic-capabilities perspective (Herold et al., 2023) to interpret why programs succeed or stall, arguing that technology must be paired with capability building across data stewardship, analytics, and operating-model change.

2. Methods

2.1. Review Design

We conducted a systematic, narrative synthesis following the PRISMA 2020 guidelines (Page et al., 2021). The review focused exclusively on peer-reviewed journals and, where relevant, peer-reviewed conference proceedings from established academic publishers. Eligible publications were in English and appeared between January 2018 and October 2025. The protocol (search strings, eligibility criteria, extraction template) was developed a priori to align with the research objectives and to support transparency and reproducibility. Searches were last updated in October 2025.

2.2. Data Sources and Search Strategy

We searched Scopus, Web of Science Core Collection, PubMed/MEDLINE, and ScienceDirect. Search strings were iteratively refined and combined with Boolean operators. Representative strings included:

- digital procurement" OR "e-procurement" OR "source-to-pay" OR "S2P") AND (platform* OR "contract lifecycle" OR "supplier relationship" OR "vendor performance
- artificial intelligence" OR "machine learning" OR "deep learning" OR "predictive") AND (procurement OR "supplier risk" OR "vendor management.
- robotic process automation" OR RPA) AND procurement AND ("business process management" OR BPM).
- blockchain AND (healthcare OR pharmaceutical) AND ("supply chain" OR "clinical trial" OR traceab*
- supply chain resilience" OR "risk management") AND (AI OR "digital twin"

To reduce retrieval bias, we combined controlled vocabulary (e.g., MeSH terms in PubMed: Purchasing, Hospital; Supply Chain Management; Artificial Intelligence) with free-text keywords. We also conducted backward and forward citation chasing on the included studies.

2.3. Eligibility Criteria

2.3.1. Inclusion criteria were

- Peer-reviewed journal articles or peer-reviewed conference proceedings;
- Focus on digital procurement tools or adjacent supply-chain technologies with clear relevance to vendor management or process harmonisation;
- Empirical findings, systematic/narrative reviews, or validated conceptual frameworks;
- English language; and
- Publication window 2018–2025.

2.3.2. Exclusion criteria were

- Non-peer-reviewed sources (white papers, trade press, blogs);
- Articles without methodological transparency (e.g., editorials without citations); and
- Studies unrelated to procurement/vendor management (e.g., clinical outcomes without supply-chain context).

2.4. Screening and Selection

Two reviewers independently screened titles and abstracts, followed by full-text eligibility assessment. Disagreements were resolved by discussion until consensus was reached. We documented reasons for exclusion at the full-text stage (e.g., non-peer-reviewed, lacking procurement focus). Inter-rater agreement on full-text decisions was 0.84 (Cohen's κ), indicating substantial agreement.

2.5. Data Extraction and Quality Considerations

We used a structured extraction template to capture bibliographic data, study design, technology domain, context (healthcare/pharma vs. cross-industry), outcomes (cycle time, compliance, transparency, resilience), and enablers/barriers (data quality, integration, skills). Because the included works comprised systematic reviews, conceptual frameworks, and empirical studies with heterogeneous designs, we did not perform a quantitative meta-analysis. Instead, we conducted a thematic synthesis and organised findings by technology domain (S2P/CLM/SRM, AI/ML, RPA/BPM, blockchain, resilience/digital twin). We considered risk of bias qualitatively, focusing on clarity of methods, transparency of reporting, and relevance to digital procurement, while acknowledging potential publication bias in rapidly evolving digital domains and construct-validity limitations in non-experimental designs.

2.6. PRISMA Flow and Study Characteristics

The search yielded 896 records. After removing 177 duplicates, 719 records were screened by title and abstract; 621 were excluded. Ninety-eight full texts were assessed; 77 were excluded (47 not peer-reviewed; 30 without a clear focus on digital procurement or vendor management). Twenty-one studies were included in the final synthesis. Of these, 11 were systematic or narrative reviews, 5 were empirical or design-science studies, and 5 were conceptual or framework papers. One study (Page et al., 2021) provided reporting guidance (PRISMA 2020) and was included as a methodological reference alongside domain-specific studies.

Figure 1 presents the PRISMA 2020 flow diagram.

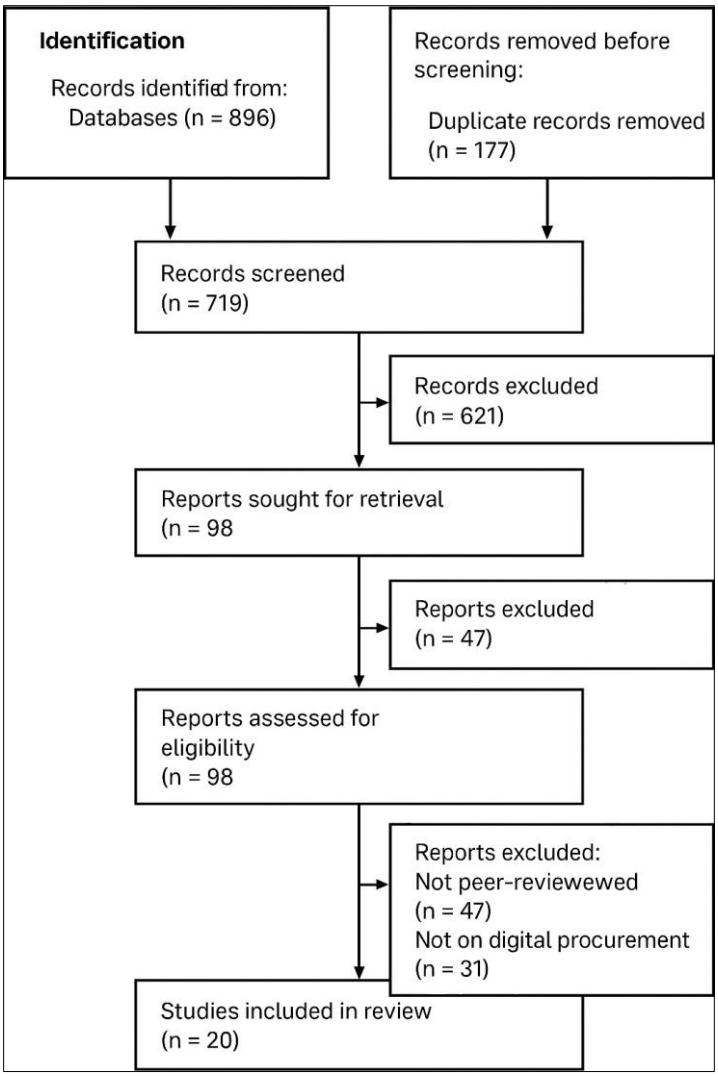

Figure 1 PRISMA 2020 flow diagram

3. Results

3.1. Platformisation of Procurement: S2P, CLM, and SRM/VPM

3.1.1. S2P as the harmonisation backbone

Across supply-chain and information-systems journals, integrated e-procurement/S2P platformisation is repeatedly linked to improvements in cycle time, compliance, and transparency when coupled with robust data governance and integration (Herold et al., 2023; Mavidis and Folinas, 2022). Reviews of "Procurement 4.0" technologies consistently identify e-procurement as a mature pillar, with adjacent digital enablers (analytics, AI/ML) layered onto unified data models (Althabatah et al., 2023; Mavidis and Folinas, 2022). These studies converge on a core point: benefits are not feature-driven alone; they are mediated by the quality of master data, taxonomy alignment, and integration with enterprise resource planning (ERP) and related operational systems (Herold et al., 2023; Althabatah et al., 2023). For global sponsors, the practical implication is to standardise category taxonomies, supplier master data, and approval matrices within the S2P suite and to enforce adoption through workflow configuration rather than optional guidance allowing harmonised procurement processes to be embodied in the platform.

3.1.2. CLM for standardisation and cycle-time reduction

Within platform suites, contract lifecycle management (CLM) enables clause libraries, deviation controls, obligation tracking, and analytics on renewals and performance. Empirical and review evidence associates CLM with shorter contract cycle times and more consistent policy and compliance adherence, particularly when template governance is

enforced (Herold et al., 2023; Mavidis and Folinas, 2022). In clinical contracting, harmonised master services agreements, work orders, and quality agreements can reduce negotiation variance and streamline study start-up.

3.1.3. SRM/VPM and KPI-driven governance

Peer-reviewed healthcare operations literature provides a transferable blueprint for KPI design and vendor oversight. A systematic review of hospital-supply chain KPIs identified 64 indicators across financial, managerial, and clinical categories, underscoring the feasibility of comprehensive yet standardised oversight frameworks (Fallahnezhad et al., 2024). Embedding SRM/VPM dashboards with harmonised definitions (e.g., site-activation velocity, protocol-deviation rates, query-resolution time) supports benchmarking across CROs and specialty vendors and aligns with inspection-readiness expectations.

3.1.4. Synthesis

The literature supports a digital-backbone model: S2P orchestrates policy and data, CLM standardises legal artefacts and obligations, and SRM/VPM translates data into governance rhythms—together enabling process harmonisation and measurable vendor performance (Herold et al., 2023; Fallahnezhad et al., 2024).

3.2. AI and ML: From Spend Analytics to Predictive Governance

3.2.1. State of the art in AI for procurement

A mixed-methods study in the Journal of Purchasing and Supply Management mapped AI's roles across the procurement process—from spend classification and anomaly detection to forecasting and decision support—and highlighted adoption barriers such as legacy integration, data quality, and workforce readiness (Guida et al., 2023). A taxonomic literature review in Artificial Intelligence Review reinforced this breadth, cataloguing AI/ML applications across procurement sub-processes and identifying research gaps in governance, bias mitigation, and explainability (Balkan and Akyuz, 2025).

3.2.2. Supplier-risk analytics and resilience

Systematic and empirical studies in supply-chain journals show that machine-learning and deep-learning models can outperform traditional approaches in predicting supply risks and disruptions (Hosseini Shekarabi et al., 2025; Zogaan et al., 2025). In a multi-industry analysis, deep-learning architectures improved forecasting accuracy for disruptions and demand signals, with case studies in pharmaceuticals highlighting logistics and inventory optimisation (Zogaan et al., 2025). A 2025 conceptual update expanded supplier-risk frameworks to explicitly incorporate environmental, social, and governance (ESG) and IT/security as primary risk dimensions, reflecting broader expectations for sustainable and cyber-secure supply bases (dos Santos et al., 2025).

Implications for harmonisation include the need to develop standardised feature sets (e.g., lead-time variance, corrective-action closure times, ESG disclosure completeness, cyber-security controls) and risk thresholds to ensure comparability across categories and regions. Combining predictive risk scores with tiered escalation pathways and pre-negotiated contingencies (e.g., backup central labs, alternate depots) can shift governance from reactive to proactive (Guida et al., 2023; dos Santos et al., 2025).

3.3. RPA and BPM: Locking in the "Golden Path"

A design-science study in Electronics demonstrated that pairing RPA with BPM-led redesign significantly reduced cycle time and labour in procurement-intensive processes (Santos et al., 2025). Complementing this, a systematic review and framework in the Business Process Management Journal framed RPA when integrated with information systems and AI as a strategic capability rather than merely a tactical tool, emphasising governance, maintainability, and scalability (Moderno et al., 2024). Collectively, these findings suggest that harmonisation is best served by redesign first, automation second, ensuring that bots encode standardised workflows rather than entrench local variants.

For clinical buyers, this means mapping the study-start-up procurement path (e.g., vendor onboarding, due-diligence checks, template selection, eSourcing, CLM routing) and only then automating stable, rule-driven steps (e.g., supplier-master updates, three-way match, invoice coding), with process mining used to detect drift from the harmonised "golden path."

3.4. Blockchain: Traceability and Integrity in Healthcare/Pharma Chains

Three peer-reviewed streams converge on blockchain's promise and constraints. First, a healthcare-supply chain systematic review in Applied Sciences catalogued applications such as provenance, smart contracts, and data integrity, and found the evidence base dominated by simulation and conceptual work; real-world deployments were scarce, indicating an immature adoption curve (Fiore et al., 2023). Second, a pharmaceutical-specific review and framework in the International Journal of Production Research identified adoption drivers (anti-counterfeit, recall efficiency) and barriers (scalability, privacy, regulatory fit), recommending staged implementation (Ghadge et al., 2023). Third, a Frontiers in Digital Health review addressed performance constraints and mitigation strategies (permissioned networks, sharding, off-chain transactions), underscoring the need for context-specific design in regulated environments (Kasyapa and Vanmathi, 2024). Complementary reviews extend the healthcare perspective to broader health-information flows, reinforcing the potential for tamper-resistant audit trails but reiterating integration and scalability challenges (Naresh et al., 2025; Niesya and Sayeed, 2024).

For clinical procurement, these findings suggest prioritising selective pilots where chain-of-custody and temperature-excursion risks are high (e.g., IMP cold chain, narcotics-controlled investigational products). Success criteria should be defined in advance (throughput/latency, audit evidence, privacy compliance) and integrated with warehouse management, transport systems, and data-logger infrastructure (Ghadge et al., 2023; Kasyapa and Vanmathi, 2024).

3.5. Supply-Chain Resilience and Digital Twins

A critical review integrating bibliometrics and network analysis identified three dominant clusters in resilience research optimisation, technology adoption, and disruption strategies and explicitly linked digital transformation (e.g., digital twins, machine learning) to real-time monitoring and decision-making (Hosseini Shekarabi et al., 2025). For procurement leaders, digital twins can serve as a harmonisation instrument, stress-testing standard operating procedures (SOPs) and contingency plans under simulated disruption scenarios before they are codified in contracts and governance. A peer-reviewed conference contribution further proposes a fuzzy maturity model for Procurement 4.0 readiness, emphasising modularity, resilience, agility, and human-centricity useful dimensions when staging capability growth (Althabatah et al., 2024).

4. Discussion

4.1. What the evidence means for vendor management in clinical research

The evidence base supports a coherent strategy for clinical-research procurement

- Build the digital backbone: adopt or extend an S2P suite tightly integrated with CLM and SRM/VPM. This creates the single source of truth required for harmonised templates, workflows, and performance dashboards (Herold et al., 2023; Mavidis and Folinas, 2022).
- Institutionalise KPI-driven governance: apply healthcare-supply chain KPI taxonomies to design tiered indicators (strategic, tactical, operational) across cost, time, quality, and sustainability; harmonise definitions to enable cross-vendor benchmarking (Fallahnezhad et al., 2024).
- Move from reactive to predictive oversight: implement AI/ML risk models and, where feasible, digital-twin stress testing to prioritise mitigations and contractually embed backup options (Guida et al., 2023; Hosseini Shekarabi et al., 2025).
- Redesign before you automate: use BPM to standardise the "golden path," then employ RPA to remove manual variation in high-volume steps; govern bots to prevent process drift (Santos et al., 2025; Moderno et al., 2024).
- Pilot blockchain selectively: target high-value chain-of-custody scenarios; use permissioned designs and rigorous performance and compliance metrics prior to scale (Ghadge et al., 2023; Kasyapa and Vanmathi, 2024; Fiore et al., 2023).

While many of the included studies are cross-industry or healthcare-generic, the mechanisms they describe—data standardisation, KPI governance, predictive risk analytics, and controlled pilots—are directly applicable to CRO, central-lab, and speciality-logistics ecosystems.

4.2. Why tools are not enough: A dynamic-capabilities lens

Herold and colleagues' systematic review shows that successful digital procurement transformations require nine micro-foundations spanning sensing (scanning technology and market options), seizing (pilot-to-scale discipline), and

reconfiguring (structures, skills, incentives) (Herold et al., 2023). Read through this lens, inconsistent outcomes in some e-procurement deployments are less about tools and more about capability gaps—particularly in data stewardship and integration engineering (Herold et al., 2023; Althabatah et al., 2023). Clinical organisations should explicitly plan capability milestones—such as data-model harmonisation, KPI governance, and model-risk management for AI—rather than measuring progress only by module go-lives.

4.3. Process harmonisation as an operating-model outcome

Harmonisation is the product of standardised artefacts (RFPs, scoring models, clause libraries), repeatable workflows (S2P/CLM), shared metrics (SRM/VPM), and coordinated risk management (AI-enabled sensing, digital-twin rehearsal). The reviewed literature provides mechanisms to make harmonisation durable: encode standards in the platform (Herold et al., 2023), drive measurement conformity (Fallahnezhad et al., 2024), and align incentives through governance and performance management (Moderno et al., 2024).

4.4. Sustainability, cybersecurity, and ethics as harmonisation vectors

The updated supplier-risk framework's expansion to ESG and IT/security (dos Santos et al., 2025) signals that harmonised procurement must operationalise sustainability (e.g., emissions intensity, labour standards) and cybersecurity requirements (e.g., secure development, data residency) as first-class selection and performance criteria. Making these dimensions explicit in CLM templates and SRM scorecards reduces ambiguity and supports consistent, defendable decisions across geographies.

4.5. Research gaps and a life-sciences–specific agenda Notwithstanding convergent findings, three gaps remain evident

- Trial-specific causal evidence: Few studies quantify how digital-procurement interventions causally affect clinical milestones such as time-to-site activation, first-patient-in, or audit findings.
- AI governance in regulated settings: Peer-reviewed work is needed on bias control, explainability, and model-risk tooling in supplier-risk decisions under GxP constraints (Guida et al., 2023; Balkan and Akyuz, 2025).
- Operational blockchain evaluations: Beyond simulations and conceptual frameworks, empirical studies in live clinical supply chains should report throughput and latency, cost-to-operate, and inspection outcomes (Fiore et al., 2023; Ghadge et al., 2023; Kasyapa and Vanmathi, 2024).

Addressing these gaps would strengthen the evidence base for digital procurement in clinical research and inform regulators' expectations around digital-tool deployment in vendor management.

Limitations

This review restricts itself to peer-reviewed sources, thereby excluding policy guidance and high-quality industry studies that often influence practice. Heterogeneity across study contexts (public vs. private, healthcare vs. manufacturing) and designs precluded formal meta-analysis; instead, we emphasised thematic synthesis. Finally, while adjacent healthcare and supply-chain evidence is informative, direct clinical-procurement outcome studies remain limited, cautioning against over-generalisation to all clinical-research settings.

Table 1 Included peer-reviewed studies (n = 21)

#	Citation (APA short)	Year	Journal/Outlet	Domain/Technology	Study type	Context / key findings (summary)
1	Herold et al.	2023	International Journal of Physical Distribution and Logistics Management	Digital procurement transformation; dynamic capabilities	Systematic literature review	Identifies nine micro-foundations (sensing, seizing, reconfiguring) essential for digital procurement; tools require capability building.
2	Mavidis and Folinas	2022	Sustainability	Public e-procurement 3.0→4.0	Critical literature review	E-procurement improves transparency and integrity; Industry 4.0 adds automation/analytics; value depends on governance.
3	Althabatah et al.	2023	Logistics	Procurement 4.0 (IoT, AI, blockchain, e-procurement)	Systematic review	E-procurement and blockchain are most studied; benefits include lead-time and cost reduction; integration is a constraint.
4	Guida et al.	2023	Journal of Purchasing and Supply Management	AI in procurement	Mixed-methods exploratory	Maps AI functions across the process; highlights data quality, integration, and workforce challenges.
5	Balkan and Akyuz	2025	Artificial Intelligence Review	AI/ML decision support in procurement	Taxonomic literature review	Broad coverage of AI/ML uses; calls for governance, bias controls, and explainability.
6	Santos et al.	2025	Electronics	RPA + BPM synergy	Design-science, quasi-experimental	Shows RPA after BPM reduces cycle time and manual effort in procurement-intensive processes.
7	Moderno et al.	2024	Business Process Management Journal	RPA as strategic capability	Systematic review + framework	Positions RPA within digital strategy; governance and maintainability are crucial to scale.
8	Fallahnezhad et al.	2024	BMC Health Services Research	Hospital supply-chain KPIs	Systematic review	Identifies 64 KPIs grouped into financial, managerial, and clinical; provides a template for vendor oversight frameworks.
9	Hosseini Shekarabi et al.	2025	Global Journal of Flexible Systems Management	Supply-chain resilience	Critical review + bibliometrics	Links digital twins and ML to real-time monitoring; proposes future research agenda for resilience.

10	Zogaan et al.	2025	Journal of Big Data	Deep learning for risk prediction	Empirical multi-case	Shows deep-learning models outperform traditional methods for disruption and demand forecasting in critical industries.
11	dos Santos et al.	2025	Applied Sciences	Supplier-risk framework update	Conceptual + bibliometrics	Adds ESG and IT/cyber to supplier-risk dimensions; aligns with SRM scorecards.
12	Shahsavari et al.	2025	Enterprise Information Systems	Supply-chain risk modelling	Systematic literature review	Advocates modelling causal relationships among contributing events in supply-chain risk.
13	Fiore et al.	2023	Applied Sciences	Blockchain in healthcare supply chains	Systematic literature review	High interest but few real deployments; smart contracts prevalent; performance and regulatory challenges noted.
14	Ghadge et al.	2023	International Journal of Production Research	Blockchain in pharmaceutical supply chains	Systematic review + framework	Identifies drivers (anti-counterfeit, recalls) and barriers (scalability, privacy); proposes a staged implementation model.
15	Kasyapa and Vanmathi	2024	Frontiers in Digital Health	Blockchain integration in healthcare	Narrative review	Reviews public and permissioned networks; discusses performance constraints and mitigation strategies.
16	Naresh et al.	2025	Peer-to-Peer Networking and Applications	Blockchain in healthcare systems	Review	Explores blockchain for EHR, clinical trials, and supply chains; notes scalability and regulatory uncertainty.
17	Althabatah et al.	2024	IFIP APMS (Springer)	Procurement 4.0 maturity (fuzzy model)	Peer-reviewed conference paper	Proposes a fuzzy maturity model across modularity, resilience, agility, and human-centricity.
18	Page et al.	2021	BMJ	PRISMA 2020 reporting	Methods guideline	Provides updated PRISMA guidance informing our review process.
19	Barve	2021	International Journal for Research in Management and Pharmacy	Blockchain for clinical-trial data	Conceptual/analytical	Argues for blockchain to enhance integrity and transparency in trial data management.
20	Niesya and Sayeed	2024	HighTech and Innovation Journal	Blockchain adoption in healthcare SCM	Review	Synthesises blockchain use in vaccines, PPE, and medical devices; advocates consortium models.
21	Patuakhali et al.	2025	Journal of Technological Enquiry and Computer Miscellaneous	E-procurement platforms (2020–2025)	Systematic review (PRISMA-guided)	Finds platformisation (CLM, SRM, risk, analytics) with outcomes contingent on integration and data stewardship.

5. Conclusions

The peer-reviewed literature supports a pragmatic path for clinical-research procurement to achieve vendor-management excellence and process harmonisation. Integrated S2P/CLM/SRM platforms provide the backbone for standardised artefacts and workflows; KPI-driven governance enables comparable performance oversight; AI/ML advances predictive risk management; RPA codifies the "golden path" at scale; and blockchain merits selective piloting where traceability is paramount. Yet the consistent throughline is that capabilities trump tools: data stewardship, integration, analytics skills, and operating-model redesign determine the magnitude and durability of benefits. A targeted research agenda especially causal, trial-specific studies and AI governance in regulated contexts—would further strengthen the evidence base and accelerate confident adoption.

Compliance with ethical standards

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