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Review Article

Digital Transformation of 3PL Services in Mega and Giga Projects: Integrating Procurement, Warehousing, Expediting, and Supplier Performance Management

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Abstract: Mega and giga projects depend on logistics networks that are temporary, capital intensive, internationally sourced and exposed to severe schedule penalties. In these environments, third-party logistics providers no longer perform a narrow transport role; they become integration partners that connect procurement, warehousing, expediting, material visibility and supplier performance management. This review examines how digital transformation reshapes those 3PL services between 2020 and 2025, with emphasis on the data, governance and operating capabilities needed for very large project ecosystems. The aim is to develop a coherent review-based framework that explains how digital platforms, analytics, automation and collaborative information systems can improve decision quality from early sourcing to site delivery. The paper adopts a structured integrative review methodology, drawing on recent literature on digital supply chains, sustainable 3PL capabilities, megaproject supply chain governance, procurement digitalisation, logistics technologies and performance measurement. The analysis identifies four service domains that must be integrated through a common digital thread: intelligent procurement support, responsive warehousing, milestone-based expediting and supplier performance management. It argues that value is created when 3PL providers transform fragmented transactions into governed visibility, predictive exception management and evidence-based supplier development. The review contributes a process architecture, a maturity pathway and managerial implications for project owners, EPC contractors and logistics providers seeking more reliable, transparent and sustainable delivery in mega and giga projects.

Keywords: Third-party logistics; digital transformation; mega projects; procurement; warehousing; expediting; supplier performance management; supply chain visibility.

INTRODUCTION

Mega and giga projects are distinguished by strategic ambition, exceptional capital intensity, long delivery horizons and dense networks of owners, engineering firms, contractors, specialist vendors, freight forwarders, customs brokers, inspection agencies and site teams. Their supply chains are not stable factory pipelines; they are project-specific systems formed under urgency, uncertainty and changing design information. Recent megaproject research shows that supply chain performance depends on coordination, governance, procurement,

production, logistics and risk management across multiple nested levels [2]. Digital transformation therefore has direct relevance because it can convert dispersed project information into decision-ready evidence. For 3PL providers, the opportunity is to move beyond shipment execution and become data-enabled orchestrators of material flow.

The need for this shift is intensified by the scale of contemporary infrastructure, energy, tourism, mobility and industrial programmes. A single giga project may include thousands of suppliers, millions of line items, modular components fabricated across continents, temperature-sensitive materials, high-value engineered equipment and highly constrained site access. Delays in one critical package can affect construction sequencing, commissioning readiness and contractual claims. Supplier evaluation studies in mega projects demonstrate that order allocation and vendor prioritisation require more than price comparison; they depend on integrated criteria covering capability, reliability, risk, capacity and delivery performance [3]. Digital 3PL services can operationalise these criteria by linking procurement events, warehouse status, manufacturing milestones and supplier scorecards.

Digital transformation is not merely the replacement of paper with screens. It refers to organisational change enabled by digital technologies, data integration and new capabilities [4,5]. In logistics and supply chain contexts, the practical outcome should be improved visibility, integration, optimisation, sustainability and responsiveness [10-12]. Recent 3PL research indicates that digital transformation, organisational resources and sustainability orientation can build capabilities, improve business performance and support more effective strategies [1]. This insight is important for mega and giga projects because the 3PL provider must coordinate with temporary project organisations whose processes, contract boundaries and data standards are often inconsistent.

Despite the rapid diffusion of supply chain platforms, research remains fragmented across procurement, logistics technology, sustainable supply chain management and project supply chains. Many studies examine digital transformation at the enterprise or manufacturing supply chain level, while fewer address the integrated service model required from 3PL providers in large capital programmes. Literature on digital procurement emphasises maturity, data governance and strategic contribution [15,16], whereas logistics studies highlight Industry 4.0 tools, automation, tracking and warehouse intelligence [11,12,29]. Megaproject studies discuss coordination and governance, yet often do not specify how 3PL systems connect procurement, expediting and supplier performance in daily execution [2]. This paper responds by synthesising these streams into a publishable review framework.

The aim of the study is to examine how digital transformation can integrate procurement, warehousing, expediting and supplier performance management within 3PL services for mega and giga projects. The objectives are fourfold: first, to identify the digital capabilities that support each 3PL service domain; second, to explain how data architecture and governance convert operational visibility into project control; third, to develop an integrated framework for digitally enabled 3PL delivery; and fourth, to outline research gaps and managerial implications. The paper is positioned as a review article, not as a technology implementation report, and therefore emphasises conceptual synthesis, argument development and practical research translation.

REVIEW METHODOLOGY

A structured integrative review method was adopted because the topic cuts across several bodies of literature rather than one mature research stream. The review focused on peer-reviewed and high-quality academic sources published from 2020 to 2025. Search strings combined terms related to digital transformation, third-party logistics, megaproject supply chains, procurement digitalisation, warehouse management, expediting, supplier evaluation, Industry 4.0 logistics, sustainable supply chains and supply chain performance. Sources were screened for relevance to at least one of the four focal domains and for contribution to capability building, governance, data integration or performance measurement. This approach is consistent with recent reviews that use structured searching while allowing conceptual integration across adjacent disciplines [2,8,10,11].

The review used three selection principles. First, sources had to address digital transformation, digital supply chain management, logistics technology, procurement, project supply chains or sustainable performance in a way relevant to 3PL services. Second, sources had to provide conceptual, empirical or review-based evidence that could inform integrated service design. Third, sources were prioritised when they connected technology with organisational resources, human skills, collaboration or performance, because digital transformation succeeds only when information systems are embedded in processes and capabilities [1,5,21-24]. Earlier foundational ideas are acknowledged indirectly through recent literature, but the reference list intentionally retains the 2020-2025 boundary requested for this study.

The extracted material was coded under six themes: project context and coordination, digital procurement, warehousing and inventory visibility, expediting and exception management, supplier performance management, and governance for integrated 3PL delivery. The coding sought relationships rather than frequency counts. For example, studies on procurement digitalisation were analysed for implications on supplier onboarding, bid evaluation, contract visibility and risk signals [15,16]. Studies on logistics technologies were analysed for warehouse automation, real-time tracking, integration and sustainability implications [11,12,17,18]. Studies on sustainable 3PL strategies were used to clarify how digital capabilities support performance, environmental accountability and social value [1,8,9].

The review is limited by the emerging nature of the topic. Few papers address the exact phrase integrating procurement, warehousing, expediting and supplier performance management in 3PL mega project environments. Consequently, the contribution of this paper is a theoretically grounded synthesis rather than a meta-analysis. The method is appropriate because complex project logistics is shaped by temporary governance, contractual fragmentation and multi-tier supplier networks that require interpretive connection across disciplines. The review therefore develops an integrative framework that can guide future empirical testing through case studies, surveys or mixed-method designs.

Table 1: Thematic synthesis of integrated digital 3PL service domains.

Service domain	Digital inputs	3PL decisions enabled	Project value contribution
Procurement integration	Supplier master data, bid history, package risk, route feasibility, contract terms	Supplier prequalification, logistics clauses, landed cost, sourcing risk escalation	Fewer downstream surprises and stronger alignment between commercial and delivery decisions
Warehouse readiness	WMS records, RFID/barcode scans, preservation logs, quality release and work-pack demand	Receipt prioritisation, consolidation, kitting, preservation, site issue control	Higher installation readiness and lower search, damage, duplicate ordering and waiting time
Expediting intelligence	Engineering approvals, manufacturing milestones, inspection status, export documents and transport bookings	Risk-based follow-up, exception escalation, supplier recovery plans and shipment sequencing	Earlier intervention before a supplier delay becomes a critical-path event
Supplier performance	Delivery reliability, document accuracy, responsiveness, quality events, sustainability indicators and claims	Supplier segmentation, corrective action, preferred supplier decisions and future allocation	Evidence-based supplier development and more transparent governance

Digital transformation of 3PL services in mega and giga projects

Digital transformation changes the role of 3PL providers from execution contractors into visibility and coordination partners. Traditional project logistics often separates procurement schedules, vendor inspection reports, freight bookings, customs documentation, warehouse receipts and site material requests into disconnected tools. The result is reactive expediting, duplicated data entry, unclear ownership and weak learning across projects. Digital supply chain studies emphasise that real value arises when data are integrated across functions and used to support decisions rather than stored in isolated systems [10,21]. For mega and giga projects, this means that every major material package should have a traceable digital record from sourcing decision to installation readiness.

The first component is procurement integration. Procurement in large projects includes supplier prequalification, tendering, commercial evaluation, technical clarification, award, contract management, purchase order release and change control. Digital procurement research shows that maturity moves from digitising records toward digitally integrated, strategic procurement [15]. In 3PL-enabled mega projects, procurement data should inform logistics feasibility before award. Heavy lifts, hazardous materials, customs restrictions, long-lead items and supplier location risks must be visible during sourcing, not after fabrication. Empirical evidence from supply chain procurement shows that digital transformation can improve competitive advantage through faster decisions, better analytics and improved collaboration [16].

The second component is warehousing and material control. Mega project warehouses include

central distribution centres, consolidation hubs, bonded stores, off-site yards, laydown areas, preservation zones and site issue points. Digital logistics technologies such as IoT, barcoding, RFID, mobile scanning, warehouse management systems, automated storage, robotics and digital dashboards can reduce mismatches between inventory records and physical stock [13,14,30]. However, warehousing value in mega projects is not only storage efficiency. It is the ability to align material availability with construction work packs, quality release, preservation status, lifting plans and installation windows. This requires integration between warehouse systems, engineering tags, procurement line items and site planning.

The third component is expediting. Expediting is often treated as chasing suppliers, but in project environments it is a structured risk management function. It tracks engineering document approval, raw material availability, manufacturing progress, inspection and test plans, non-conformance closure, packing, shipment readiness and handover documentation. Digitally enabled expediting converts milestone updates into predictive warnings. Instead of discovering delays after a supplier misses a promised date, the 3PL control tower can monitor weak signals such as late drawings, inspection rescheduling, missing certificates or repeated partial shipments. This logic is consistent with digital transformation research that links data-driven operations to agility, responsiveness and innovation [4,10,23].

The fourth component is supplier performance management. Supplier performance in mega and giga projects must combine delivery reliability, quality, documentation accuracy, responsiveness, safety compliance, sustainability performance, claim behaviour and improvement commitment. Supplier evaluation research in mega projects shows that multi-criteria methods are needed because supplier selection and order allocation have interdependent technical, commercial and risk effects [3]. Digital SPM should therefore provide a living scorecard, not a one-time vendor rating. It should draw from procurement, expediting, warehousing and site feedback to make performance evidence transparent. Over time, scorecards can support supplier segmentation, corrective actions, framework agreements and more resilient sourcing decisions.

The enabling layer is the project logistics control tower. A control tower is not simply a dashboard; it is an operating model in which data governance, exception rules, roles, escalation rights and decision rhythms are defined. For 3PL providers, the control tower should connect order status, supplier milestones, shipment movements, warehouse inventory, customs status, inspection outcomes and site demand. Research on digital transformation and operations emphasises that capabilities arise from technology, human skills and process alignment rather than technology alone [1,22,24]. Therefore, the digital 3PL control tower must be staffed by people who understand logistics, procurement, engineering dependencies and project risk, not only software administration.

Digital integration also supports sustainability and social value. Recent literature shows that sustainable supply chain management increasingly requires economic, environmental and social performance, while many digital studies still overemphasise economic and environmental outcomes [1,8,9,17]. In mega and giga projects, 3PL providers can reduce empty runs, consolidate shipments, optimise routes, improve packaging reuse, prevent material waste and capture supplier compliance data. They can also support social outcomes by improving labour planning, reducing unsafe site congestion, monitoring contractor responsiveness and enhancing transparency for local suppliers. Digital transformation thus supports broader project value when sustainability metrics are embedded in logistics decisions [18-20].

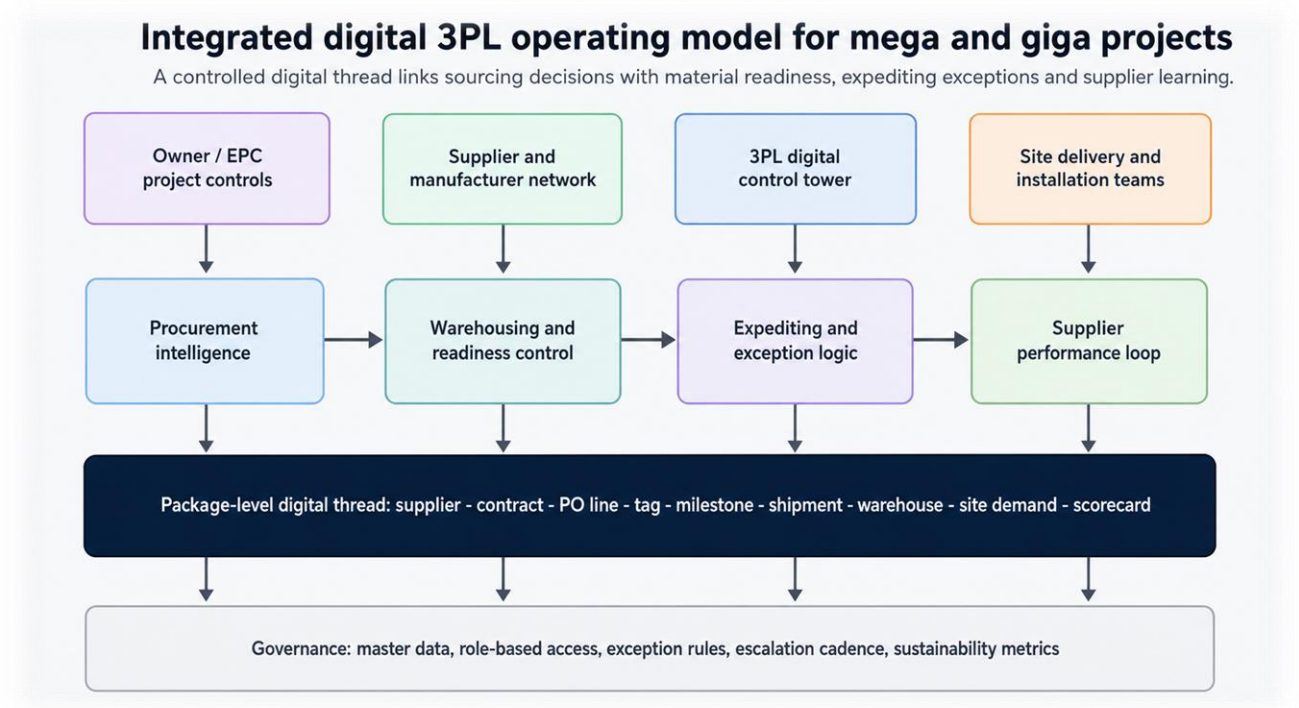

Figure 1: Integrated digital 3PL operating model for mega and giga project logistics.

Integrating procurement, warehousing, expediting and supplier performance

The core argument of this paper is that digital transformation creates the greatest value when the four service domains are managed as an integrated process architecture. Procurement without logistics intelligence may award packages to suppliers that appear competitive but create hidden transport, customs or schedule risks. Warehousing without procurement context may store materials efficiently while failing to prioritise critical path items. Expediting without warehouse and site feedback may accelerate shipments that cannot be received or installed. Supplier performance management without operational evidence may become subjective and disconnected from project outcomes. Integration solves these weaknesses by creating one shared version of material truth.

A useful starting point is to define the material package as the unit of integration. Each package should have a unique identifier linked to supplier, contract, purchase order, engineering tag, manufacturing milestone, inspection requirement, shipment plan, warehouse location, preservation rule and site demand date. This digital thread is essential because mega projects operate through thousands of handovers. Research on Industry 4.0 technologies highlights integration and optimisation as the most common benefits, while high cost, data quality and human resource issues remain major challenges [29]. A package-level data model reduces these risks by giving each function a common reference point.

Procurement integration begins during sourcing strategy. 3PL providers should support route feasibility, packaging assumptions, customs classification, Incoterms review, supplier logistics capability assessment and total landed cost modelling before contracts are awarded. Digital procurement systems can capture supplier documents, bid responses, clarification history and award rationale [13,14]. When linked to logistics rules, these systems reveal whether a supplier can meet preservation requirements, export controls, inspection windows or consolidation plans. The 3PL provider becomes an advisor to procurement rather than a downstream carrier. This shift is critical for mega projects because poor early logistics assumptions often become expensive schedule problems later.

Warehouse integration requires synchronising inbound flow with construction readiness. Digital WMS platforms should record not only receipt and location but also condition, quality status, preservation requirements, shelf life, ownership, work-package allocation and readiness for issue. The most advanced warehouses in project environments use mobile scanning, geofenced yards, image capture, automated alerts and inventory analytics. Yet technology must be matched with governance. Material should not be issued simply because it is physically available; it should be released when quality documentation, installation access, lifting capacity and site sequence are aligned. This connects warehousing to project controls and

reduces wasted movement, damage and searching time.

Expediting integration requires milestone logic. Each supplier package should have planned and actual dates for engineering approval, procurement of subcomponents, production start, inspection hold points, factory acceptance, packing, shipment booking, export clearance, arrival, warehouse receipt and site issue. Deviations should trigger exception workflows based on criticality rather than generic reminders. Analytics can classify risks by supplier history, commodity type, country risk, route reliability and previous non-conformances. Studies on big data, predictive analytics and sustainable supply chains show that analytics capabilities can improve visibility and support better operational decisions [23,27]. In mega projects, the practical value is earlier intervention before supplier slippage becomes irreversible.

Supplier performance integration closes the feedback loop. Every delay, damage event, documentation error, non-conformance, missed inspection or successful recovery should update the supplier scorecard. The scorecard should include leading and lagging indicators. Leading indicators include late document submissions, unresolved clarifications, expediting responsiveness and risk exposure. Lagging indicators include on-time delivery, quality defects, claims, safety incidents and sustainability compliance. Supplier integration and trust influence organisational performance, but trust should be supported by transparent evidence [24]. Digital SPM allows project teams to distinguish between systemic supplier weakness, unrealistic project requirements and external disruption.

The integration challenge is also contractual. Mega and giga projects often have separate contracts for EPC, construction packages, freight forwarding, warehousing, customs brokerage and supplier inspection. If data-sharing obligations are not embedded in contracts, the 3PL provider may lack the authority to obtain accurate milestone updates or supplier documentation. Sustainable and digitally enabled strategies require governance arrangements that define data ownership, frequency, quality standards, escalation routes and confidentiality [1,25]. Procurement contracts should require suppliers to update agreed milestones and provide machine-readable documents. 3PL contracts should include service-level indicators for visibility, exception closure and data accuracy, not only freight cost and delivery time.

Table 2: Maturity pathway and performance emphasis for digitally enabled project logistics

Maturity level	Operating practice	Data requirement	Primary KPI emphasis
1. Digitised records	Electronic PO, invoice, shipment and warehouse documents replace paper files	Basic master data and document repository	Document completeness and retrieval time
2. Connected status	Supplier, freight and warehouse updates are linked to package identifiers	Common package code, milestone dictionary and role ownership	Visibility completeness and update timeliness
3. Readiness control	Materials are managed against site work packs, quality release and preservation rules	WMS, inspection status, site demand and preservation data	Warehouse readiness rate and issue accuracy
4. Predictive exceptions	Risk scoring highlights weak signals and prioritises expediting effort	Historical supplier performance, route reliability and milestone variance	Exception closure speed and predicted delay accuracy
5. Learning network	Supplier development and future sourcing decisions use accumulated evidence	Governed scorecards, lessons learned and cross-project benchmarking	Supplier improvement, claims reduction and sustainable impact

Proposed digital 3PL operating framework

The proposed framework is built around five layers. The first layer is strategic alignment, where the project owner, delivery partner and 3PL provider agree the logistics operating philosophy, risk appetite, data standards and sustainability priorities. The second layer is the digital thread, where procurement, expediting, warehousing and supplier scorecards share package identifiers and master data. The third layer is execution orchestration, where control tower teams manage exceptions, prioritise critical materials and coordinate decisions across organisations. The fourth layer is performance intelligence, where analytics convert events into trends, forecasts and supplier development actions. The fifth layer is continuous learning, where lessons from each package feed future sourcing, warehouse design and logistics planning.

This layered framework reflects the resource-based view embedded in recent 3PL and digital transformation literature. Technology

generates limited value if organisational resources and human capabilities are weak [1,22]. Therefore, the framework requires data engineers, procurement specialists, logistics planners, warehouse supervisors, expeditors, contract managers and supplier development professionals to use shared information. Digital transformation should be framed as capability development rather than system installation. The provider that can translate data into action becomes a strategic logistics partner.

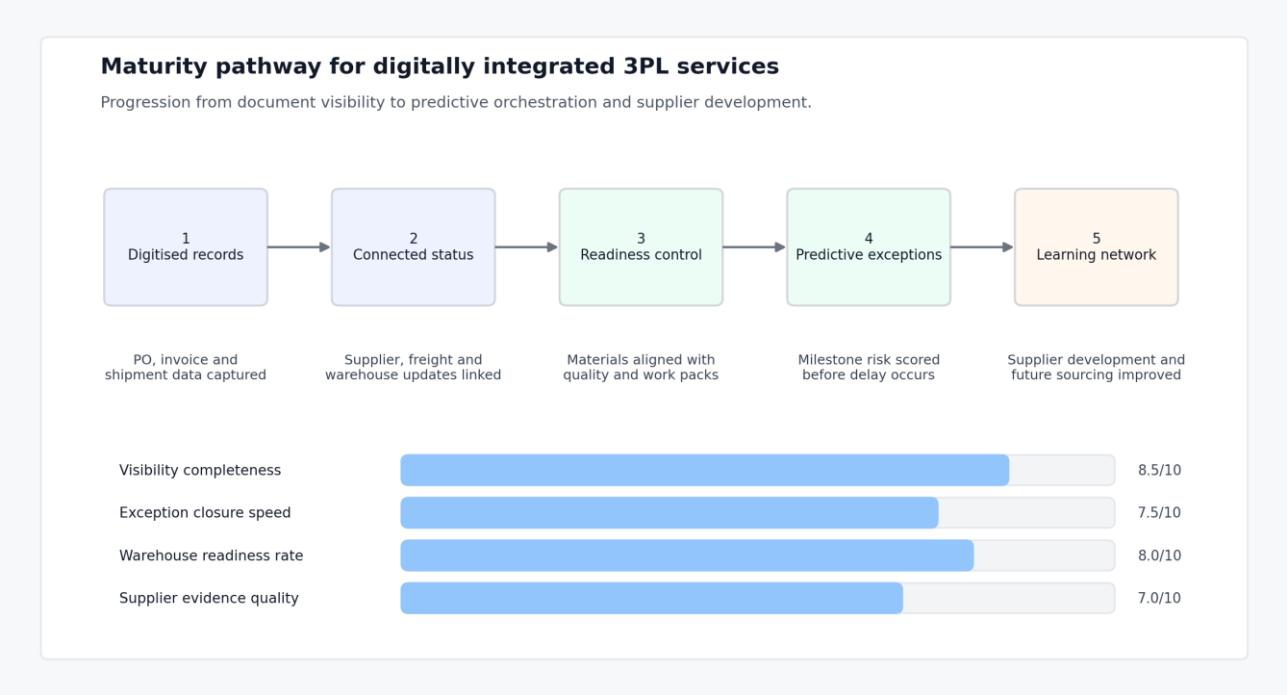

Figure 2: Maturity pathway from visibility to predictive orchestration and supplier learning.

A mature operating framework also needs data quality controls. Poor data are particularly damaging in mega projects because small errors propagate through schedules, warehouse plans and supplier scorecards. Master data should define commodity codes, package identifiers, supplier names, tag numbers, purchase order lines, Incoterms, route codes and warehouse zones. Transaction data should capture time stamps, responsible parties and evidence attachments. Performance data should be calculated from agreed rules. Recent studies on digital supply chains identify information quality, integration and analytics as foundations for resilience and performance [21,23]. Without these foundations, dashboards may create confidence without accuracy.

Cybersecurity and access governance are additional requirements. Project logistics data may include commercial prices, supplier capacity, routes, security-sensitive equipment, customs documents and personal information. Integrated platforms should therefore apply role-based access, audit trails, secure interfaces and clear retention rules. These controls are not optional because giga projects often include national infrastructure, public investment or strategic assets. Digital transformation must balance openness for collaboration with protection of sensitive information. The 3PL provider should be able to show that data sharing improves control without exposing owners or suppliers to avoidable risk.

The framework should also be modular. Not every project can implement advanced automation from day one, especially when suppliers vary widely in digital maturity. A practical roadmap begins with master data governance and digital document control, then adds milestone expediting, WMS integration, shipment tracking, supplier scorecards, predictive analytics and decision optimisation. This sequencing aligns with research on digital maturity, where organisations progress from digitisation to digitalisation and then to digitally transformed capabilities [4,13]. Mega and giga projects benefit from early wins, but the roadmap must remain coherent so that each module strengthens the same data model.

DISCUSSION AND IMPLICATIONS

The review indicates that digital 3PL transformation is primarily an integration problem, not a technology shopping problem. Many technologies are available, including IoT sensors, mobile warehouse scanning, supplier portals, analytics, cloud platforms, digital twins, robotic process automation and blockchain-enabled traceability [11,12,15,18,29]. However, value

depends on aligning these tools with project decisions. For example, RFID has little strategic value if warehouse locations are not connected to work-pack demand. Supplier portals create little value if milestone definitions are ambiguous. Predictive analytics cannot function if supplier updates are late or inconsistent. Managers should therefore prioritise process clarity before automation.

For project owners, the main implication is that 3PL involvement should begin during procurement planning, not after materials are ready to ship. Early logistics input can improve supplier selection, packaging strategy, route planning, consolidation, customs preparation and warehouse capacity. For EPC contractors, digital integration can reduce the friction between engineering, procurement, construction and logistics teams. For 3PL providers, the implication is capability investment: they need analysts, data governance competence, project controls literacy and supplier relationship skills. The provider that only sells transport capacity will be less valuable than the provider that can protect critical path materials.

For warehousing managers, the findings highlight the need to move from stock keeping to readiness management. In construction-driven project logistics, a material is useful only when it is identifiable, accessible, preserved, quality released and aligned with a work pack. Digital warehousing should therefore track readiness status, not just quantity. For expediting managers, the findings suggest a shift from manual follow-up to risk-based intervention. The expediting team should spend less time requesting routine updates and more time resolving exceptions with high schedule impact. For supplier performance teams, scorecards should become developmental tools that guide corrective action and future sourcing rather than retrospective blame documents.

Sustainability implications are equally important. Digital 3PL platforms can support reduced transport emissions through consolidation, route optimisation and better load planning. They can reduce waste by preventing duplicate ordering, misplaced materials and preservation failures. They can improve social outcomes by increasing transparency, strengthening local supplier participation and reducing unsafe congestion around sites [17-20]. Nevertheless, sustainability metrics must be designed into the operating model. If carbon, waste, safety and local content indicators are not captured at transaction level, the project will struggle to demonstrate credible sustainable impact.

The review also identifies barriers. First, data ownership is contested because owners, EPC contractors, suppliers and 3PL providers may each treat information as a source of power. Second, supplier digital maturity varies, particularly across small or specialised vendors. Third, project teams often prioritise immediate delivery pressure over disciplined data capture. Fourth, contractual indicators still reward shipment activity more than visibility, prevention or learning. Fifth, technology costs can be difficult to justify when project organisations are temporary. These barriers explain why digital transformation should be governed as a programme-level capability rather than a local IT initiative.

The conceptual contribution is especially relevant because mega and giga projects are simultaneously permanent and temporary. The physical asset may operate for decades, yet the delivery organisation is assembled for a finite programme and then disbanded. This creates a learning paradox: the project generates rich logistics knowledge, but lessons are often lost when teams demobilise. A digitally mature 3PL model can reduce this loss by codifying decisions, exceptions, supplier behaviours and warehouse outcomes in reusable data structures. Over successive packages, the platform can identify which suppliers require early inspection, which routes create customs exposure, which warehouses experience congestion, and which material families are frequently damaged or late. Such learning is valuable only when captured in comparable formats and governed by clear ownership. The 3PL provider can therefore become a custodian of project logistics memory, helping owners transfer insight from one phase, region or contractor package to another. This is a stronger role than routine outsourcing because it creates cumulative capability across the project ecosystem.

A further contribution concerns the relationship between control and collaboration. Large projects often respond to uncertainty by tightening approvals, adding reports and escalating meetings. These actions may increase administrative burden without improving material flow. Digital 3PL integration offers a different form of control: it makes exceptions visible, clarifies accountability and supports targeted intervention. When procurement, warehouse, expediting and supplier data share the same package logic, teams can discuss evidence rather than perceptions. This can improve trust because suppliers understand how performance is measured, while project teams can see whether delays arise from supplier behaviour, late engineering release, inspection bottlenecks or transport disruption. In this way, transparency becomes a coordination mechanism rather than merely a compliance requirement. The integrated model also supports proportional governance. Low-

risk items can move through standard digital workflows, while high-risk or critical-path packages receive enhanced monitoring, supplier engagement and executive attention. This proportionality is essential in giga projects, where attempting to manage every item with the same intensity would overwhelm teams and dilute focus. Consequently, the proposed framework aligns governance effort with material criticality, allowing scarce managerial attention to be directed toward the decisions that most influence schedule, cost, safety and sustainable outcomes.

It also positions digital logistics as an enterprise capability, since the data generated by one package can safely improve future procurement negotiation, warehouse design, expediting priority rules and supplier development across the wider programme portfolio and subsequent operating phases.

Future research directions

Future research should test the proposed framework through comparative case studies of mega and giga projects in infrastructure, energy, industrial zones, tourism destinations and smart city programmes. Such studies could examine how different contractual models influence data sharing and 3PL authority. Survey research could measure the relationship between digital 3PL maturity, supplier performance, project schedule adherence and sustainability outcomes. Longitudinal studies would be valuable because the benefits of supplier development and data learning may appear across project phases rather than within one delivery window. Research should also explore how local supplier ecosystems can participate in digital project logistics without being excluded by complex platform requirements.

Another promising research direction concerns metrics. Existing literature provides strong foundations for supply chain performance, sustainability and digital capability, but mega project logistics needs more specific indicators. Potential measures include package visibility completeness, expediting prediction accuracy, warehouse readiness rate, supplier documentation reliability, critical-path material availability, exception closure time, claims reduction, carbon intensity per tonne-kilometre and local supplier development. Researchers could also investigate whether predictive analytics improves expediting outcomes compared with traditional milestone reporting. These topics would strengthen the evidence base for treating 3PL providers as strategic partners in project delivery.

CONCLUSION

This review has examined digital transformation of 3PL services in mega and giga projects through the integration of procurement, warehousing, expediting and supplier performance management. The central conclusion is that digitally enabled 3PL value emerges from a governed digital thread that connects material packages across organisational boundaries. Procurement integration improves supplier and logistics decisions before award. Warehousing integration converts storage into installation readiness. Expediting integration enables predictive exception management. Supplier performance integration closes the loop between operational evidence and future sourcing. Together, these capabilities help project organisations reduce delays, improve transparency, support sustainability and strengthen collaboration.

The paper contributes by synthesising recent 2020-2025 literature into a coherent operating framework tailored to large project logistics. It shows that digital transformation should be understood as capability development involving technology, process, data governance and skilled people. For practice, the framework offers owners, EPC contractors and 3PL providers a pathway for designing digital control towers, package-level data models, supplier scorecards and readiness-based warehousing. For research, it identifies a need for empirical validation of integrated 3PL maturity and its effects on project outcomes. As mega and giga projects continue to expand in complexity, the digitally integrated 3PL provider will become central to reliable, sustainable and accountable delivery.

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