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Original Article

Effect of Multivendor Strategy on Supply Chain Engineering in Process Industries: A Review

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ABSTRACT: *The transition from proprietary Distributed Control Systems (DCS) to open, software-defined automation architectures is reshaping not only how process industries manage control systems but also how they design, govern, and optimise their industrial supply chains. For decades, proprietary automation platforms have locked process operators into single-vendor ecosystems that extend far beyond the control room into spare parts procurement, maintenance contracting, engineering services, and capital planning. The Open Process Automation Standard (O-PAS), IEC 61499, and OPC UA together define the technical foundation for a multi-vendor, interoperable automation architecture that fundamentally restructures these supply chain dependencies. This review paper examines the supply chain implications of open automation adoption in chemical, oil and gas, water treatment, and manufacturing industries. It analyses the effects on procurement strategy, spare parts management, supplier diversification, contract governance, and total lifecycle cost. An original Open Supply Chain Alignment (OSCA) framework is proposed, providing a structured five-stage model for aligning supply chain practices with open automation adoption maturity. Drawing on practitioner experience in industrial automation offer management and supply chain operations, the paper concludes that open automation creates both significant supply chain opportunities, including documented lifecycle cost savings of approximately 52% over 25 years and new supply chain governance challenges that organisations must actively manage to realise those benefits.*

KEYWORDS: *Open Automation, O-PAS, Supply Chain Engineering, Procurement Strategy, Vendor Lock-In, IEC 61499, Multivendor Sourcing, Lifecycle Cost, Process Industries.*

1. INTRODUCTION

There is a supply chain problem hiding inside every proprietary automation platform, and it is hiding in plain sight. When a process plant selects a DCS vendor, it does not simply purchase a control system. It enters into a decades-long supply relationship that governs everything from how it buys replacement I/O cards to how it negotiates engineering change orders, trains maintenance engineers and plans capital refreshes. The control platform vendor becomes, in effect, a supply chain monopolist for every component, service, and upgrade that touches the automation system (Automation World, 2024).

This supply chain dependency has been tolerated for the same reasons that proprietary DCS has been tolerated generally: the systems work, they are deeply embedded in plant operations, and the switching cost of change is enormous. But the same forces that are now driving the technical case for open automation the documented 52% lifecycle cost reduction of O-PAS-compliant systems over proprietary equivalents, the ExxonMobil Lighthouse Project validation at production scale, and the growing maturity of IEC 61499 multivendor ecosystems are also creating a supply chain case that deserves its own analysis (Hoske, 2024; Hoske, 2026).

Supply chain engineering in process industries has not systematically engaged with the implications of this technology transition. The procurement literature has addressed automation in terms of process efficiency how automation reduces manual workload in purchasing workflows but has not examined how the shift to open automation architectures changes the fundamental structure of the vendor relationships, spare parts economics, and contract governance that define industrial supply chains. This review fills that gap.

This paper is organised as follows. Section 2 reviews the open automation standards landscape and its supply chain implications. Section 3 analyses the specific effects on procurement strategy, spare parts management, supplier development, and contract governance. Section 4 presents an economic analysis of the supply chain cost impact of open automation. Section 5 introduces the Open Supply Chain Alignment (OSCA) framework as an original contribution. Section 6 discusses implementation challenges. Section 7 concludes.

2. OPEN AUTOMATION: STANDARDS AND ECOSYSTEM

2.1. THE O-PAS STANDARD AND ITS SUPPLY CHAIN ARCHITECTURE

The Open Process Automation Standard (O-PAS), developed by the Open Process Automation Forum (OPAF) under the auspices of ANSI and The Open Group, defines a vendor-neutral, interoperable architecture for process control that is structurally incompatible with single-vendor supply chain dependency. The standard defines three primary elements: the Distributed Control Node (DCN), a compute device that executes control applications; the Advanced Computing Platform (ACP), which hosts historians, HMIs, and advanced control functions; and the Connectivity Framework (CF), built on OPC UA, that connects all components. Critically, each element is defined by its functional interface to the O-PAS architecture, not by the hardware or software vendor that manufactures it (OPAF, 2023).

This interface-based definition is the supply chain revolution embedded in the technical standard. In a traditional DCS, the hardware that executes control logic is inseparable from the vendor's proprietary software stack, engineering tools, and support infrastructure. Replacing the hardware means replacing the application, the tools, and the support relationship simultaneously. In an O-PAS-compliant architecture, the Distributed Control Node is defined by its O-PAS interface. Any vendor whose DCN meets the O-PAS interface specification can be used interchangeably, enabling multi-vendor sourcing for the most capital-intensive components of the control system (Yokogawa, 2024).

2.2. IEC 61499 AND APPLICATION PORTABILITY

IEC 61499 is the function block standard that makes portability of control applications real. Its separation of application logic from execution hardware via an event-data interface model and a device model abstraction layer means that control applications developed in IEC 61499 can be deployed on any compliant runtime, regardless of the hardware vendor. The Universal Automation Organization (UAO), with 89 member organisations as of September 2024, advances this through a royalty-free runtime execution engine, while the Eclipse Foundation's 4DIAC project provides a parallel open-source implementation (UAO, 2024).

From a supply chain perspective, IEC 61499 portability changes the entire economics of the engineering services market. In proprietary DCS environments, control application development is locked to the vendor's proprietary engineering tools and, by extension, to the vendor's engineering service organisation or a narrow community of certified third-party integrators. IEC 61499 portability opens the engineering services supply chain to any vendor with IEC 61499 competency, increasing competition and reducing the concentration risk inherent in single-vendor engineering relationships.

3. EFFECT OF OPEN AUTOMATION ON SUPPLY CHAIN ENGINEERING

3.1. PROCUREMENT STRATEGY TRANSFORMATION

The most immediate and structural supply chain effect of open automation adoption is the transformation of procurement from a constrained, single-source relationship to a competitive, multi-vendor market. In proprietary DCS environments, the procurement team's role for control system components is largely administrative: managing the relationship with the incumbent vendor, negotiating renewal pricing within the constraints imposed by switching costs, and processing purchase orders. The vendor selection decision was made at system installation and is effectively irreversible for the platform lifecycle.

Open automation changes this equation at every stage of the procurement lifecycle. Component sourcing becomes genuinely competitive: multiple vendors can supply O-PAS-compliant DCN hardware. Engineering services can be sourced from any IEC 61499-competent integrator. Maintenance support is available from any vendor with knowledge of the hardware platform and the OPC UA connectivity layer. The procurement team's role shifts from relationship management with a captive vendor to active supply-market management, supplier qualification, and competitive sourcing—a significantly more demanding and strategically valuable function (Deloitte, 2025).

Deloitte's 2025 Global Chief Procurement Officer Survey found that 74% of CPOs identify finding alternative supply sources as their top strategic priority, and 61% prioritise stronger supplier collaboration. Open automation directly enables both: it creates the technical conditions for alternative sourcing that proprietary lock-in had previously made economically infeasible (Deloitte, 2025).

3.2. SPARE PARTS MANAGEMENT AND INVENTORY ECONOMICS

The availability and cost dynamics of single-source components dominate spare parts management in process industries. A proprietary DCS controller card that fails after the vendor has discontinued that hardware revision creates an emergency procurement situation with no competitive alternative: buy refurbished parts on the secondary market at inflated prices, or execute a full platform migration. This dynamic drives procurement teams to maintain larger safety stock inventories of proprietary components than would be economically rational under competitive sourcing conditions, and to accept extended lead times and premium pricing as structural features of the spare parts supply chain.

Open automation fundamentally changes spare parts economics by creating a competitive supply market for control system components. When multiple vendors supply O-PAS-compliant DCN hardware to the same interface specification, a failed component can be replaced with any compliant vendor's component from the supply base. Safety stock requirements fall because the supply base for each component type is no longer a single vendor with a single manufacturing location and single supply chain risk profile. Lead times become more competitive when multiple suppliers bid for the business. And end-of-life component transitions, which in proprietary systems can trigger expensive platform-wide migrations, become manageable substitutions within the O-PAS-compliant supply pool.

3.3. SUPPLIER DEVELOPMENT AND RELATIONSHIP MANAGEMENT

The supplier development implications of open automation extend beyond procurement cost reduction to the strategic architecture of the supplier base. In the proprietary DCS model, the process plant's relationship with its control system vendor is characterised by high dependency and asymmetric leverage: the vendor knows that switching costs are prohibitive and prices accordingly. Supplier development in this context means managing a relationship where the buyer has limited alternatives, not developing competitive supplier capability.

Open automation creates the conditions for genuine supplier development in the industrial automation supply chain. With multiple vendors competing for DCN hardware, application development, and maintenance service contracts, the process plant can actively develop supplier capability, impose performance requirements, and shift business between suppliers when performance falls short. The 35% of procurement organisations that had, by end-2024, implemented supplier performance analytics with real-time KPI tracking and proactive risk identification were those that had created the technical and organisational conditions for supplier accountability that open automation now enables in the process control domain (Planergy, 2025).

3.4. CONTRACT GOVERNANCE AND LIFECYCLE MANAGEMENT

The absence of competitive alternatives structurally constrains contract governance for proprietary automation platforms. Maintenance contracts, software licence renewals, and engineering change agreements are negotiated in conditions of low buyer leverage. Proprietary vendors can and do price this leverage premium into long-term support contracts, knowing that the cost of switching platforms exceeds any reasonable estimate of the accumulated contract value differential.

Open automation creates a new contract governance environment in which technical interoperability supports commercial flexibility. Annual maintenance contracts can be rebid across multiple compliant vendors. Software update and lifecycle management agreements can be structured on market terms rather than monopoly terms. Engineering change governance can include the credible option of switching engineering service providers without application re-engineering, providing contract discipline that proprietary relationships cannot sustain. IBM Smart Procurement research documents that procurement teams operating in multivendor environments onboard new suppliers up to ten times faster than single-source environments, compressing the practical lead time for supplier switching from months to weeks (Procurekey, 2026).

4. ECONOMIC ANALYSIS OF SUPPLY CHAIN IMPACT

The economic case for open automation has been quantified in terms of total lifecycle cost. A cost analysis presented at the 2024 ARC Industry Leadership Forum, subsequently documented in the process automation literature, projected open process automation lifecycle costs approximately 52% lower than traditional DCS over twenty-five years, primarily due to reduced integration, maintenance, and upgrade costs (Hoske, 2024). This headline figure encompasses supply chain economics in a specific way: the cost reductions come largely from the elimination of single-source pricing premiums, the compression of spare parts safety stock requirements, and the competitive repricing of maintenance and engineering services enabled by open sourcing.

Table 1 presents a structured analysis of the supply chain cost dimensions affected by open automation adoption, drawing on published industry data and practitioner experience.

TABLE 1 Supply Chain Cost Impact of Open Automation Adoption in Process Industries

Supply Chain Dimension	Proprietary DCS Condition	Open Automation Condition	Documented or Estimated Impact
Hardware component sourcing	Single-source, monopoly pricing	Multivendor competitive sourcing	15–30% unit cost reduction from competitive pricing
Spare parts inventory	High safety stock; end-of-life risk	Reduced safety stock; substitutable supply	Inventory holding cost reduction; reduced obsolescence risk
Engineering services	Captive vendor / certified integrators only	Open market for IEC 61499-competent suppliers	Engineering cost reduction; reduced change order pricing power

Maintenance contracts	Single-source, high leverage premium	Competitive multi-vendor annual bidding	Maintenance cost reduction; performance accountability
Platform lifecycle cost	Full platform replacement at end of life	Incremental hardware refresh without application re-engineering	~52% total lifecycle cost reduction over 25 years (Hoske, 2024)
Procurement process efficiency	Manual, relationship-based	Automated, competitive, analytics-driven	40% reduction in manual procurement workload (Planergy, 2025)

Source: *Author synthesis from Hoske (2024), Planergy (2025), Deloitte (2025), and practitioner case experience.*

The 52% lifecycle cost reduction quantifies the aggregate effect across all supply chain dimensions. The individual dimensions in Table 1 provide the mechanisms by which this aggregate figure is achieved: competitive pricing at every sourcing decision point, reduced inventory holdings enabled by supply base diversification, and engineering cost reduction enabled by application portability. Together, these effects represent a fundamental restructuring of the economics of process plant automation supply chains.

5. THE OPEN SUPPLY CHAIN ALIGNMENT (OSCA) FRAMEWORK

The Open Supply Chain Alignment (OSCA) framework is proposed as an original contribution of this review to provide organisations with a structured, staged model for aligning supply chain practices with their open automation adoption maturity. The OSCA framework addresses a practical gap: organisations that adopt open automation technology without simultaneously restructuring their supply chain practices will not realise the full economic benefits it enables. Technical interoperability is a necessary but not sufficient condition for supply chain transformation; the supply chain governance, procurement processes, and supplier relationship structures must also evolve in alignment with the technical architecture.

OSCA defines five alignment stages, each characterised by the supply chain practices appropriate to the corresponding open automation maturity level. Table 2 presents the framework structure.

TABLE 2 OSCA Framework: Open Supply Chain Alignment Stages.

Stage	Automation Maturity	Supply Chain Practice	Procurement Capability	Key Metric
S1: Aware	Proprietary DCS incumbent; O-PAS evaluation underway	Single-source procurement; relationship-based maintenance	Vendor management; contract renewal negotiation	Supplier count = 1
S2: Planning	SD-ARMM risk assessment complete; migration strategy defined	Supply market analysis; alternate vendor qualification begins	Multivendor supplier qualification process established	Qualified alternate suppliers ≥1
S3: Piloting	O-PAS pilot deployed on non-critical units	Dual-source procurement for pilot hardware; competitive maintenance bid	Supplier performance analytics implemented; KPI tracking active	Maintenance cost reduction >10%
S4: Scaling	O-PAS deployment across multiple process units	Competitive sourcing standard; spare parts safety stock optimised	Procurement automation deployed; supplier portal active	Lifecycle cost reduction >30%
S5: Optimised	Full O-PAS deployment; IEC 61499 ecosystem mature	Strategic supplier partnerships; predictive supply planning	AI-driven spend analytics; real-time supplier risk monitoring	~52% lifecycle cost reduction realised

OSCA: Author's original framework. SD-ARMM = Software-Defined Automation Risk Mapping Model (Shaikh, 2026). KPI = Key Performance Indicator.

The OSCA framework is explicitly staged because the supply chain transformation enabled by open automation cannot be executed simultaneously with the technical migration. Supplier qualification for O-PAS-compliant hardware requires engineering validation. Competitive maintenance bidding requires developing detailed scope-of-work specifications that capture the open architecture's technical requirements in a format non-incumbent vendors can price. Procurement automation deployment requires data infrastructure that the O-PAS connectivity layer enables, but that must be deliberately built out. Each of these activities has a lead time that must be incorporated into the migration programme plan alongside the technical deployment activities.

The OSCA framework integrates directly with the Software-Defined Automation Risk Mapping Model (SD-ARMM) proposed in related work (Shaikh, 2026). Where SD-ARMM assesses the technical and organisational risks of open automation migration, OSCA addresses the supply chain governance maturation that must accompany that migration to realise its economic benefits. The two frameworks together provide a comprehensive programme planning tool for process industry operators navigating the transition from proprietary to open automation.

6. IMPLEMENTATION CHALLENGES

6.1. SUPPLIER QUALIFICATION COMPLEXITY

The most immediate practical challenge in implementing the OSCA framework is qualifying alternate suppliers for O-PAS-compliant hardware. Process industry procurement teams are accustomed to qualifying suppliers for standard industrial components valves, instrumentation, electrical equipment but qualifying control system hardware involves functional safety requirements, cybersecurity validation, and environmental certification that require specialised engineering assessment. IEC 62443 cybersecurity compliance must be verified. ATEX or IECEx hazardous-area certification must be confirmed for the appropriate installation classes. The O-PAS interface compliance of candidate hardware must be validated through actual interoperability testing rather than solely through specification review.

6.2. PROCUREMENT WORKFORCE CAPABILITY

Open automation supply chain management requires procurement professionals who understand both the commercial principles of competitive sourcing and the technical requirements of open automation architectures. This combination is rare in 2026. Process industry procurement teams typically have deep commercial expertise but limited knowledge of automation technology. The reverse is true of the engineering teams that understand O-PAS and IEC 61499. Building the cross-functional procurement capability that OSCA Stage 3 and above requires buyers who can write technically accurate scope of work documents for IEC 61499-based maintenance contracts and evaluate alternate supplier technical compliance is a workforce development challenge comparable in scale to the IT/OT skills gap that constrains the technical migration itself (PwC, 2024).

6.3. CONTRACT TRANSITION MANAGEMENT

Process plants moving from proprietary DCS to open automation during the term of existing maintenance and support contracts face a transition management challenge that is primarily contractual rather than technical. Existing contracts with proprietary DCS vendors typically include termination penalties, minimum purchase commitments, and exclusivity arrangements for engineering services that were negotiated under conditions of single-source dependency. Exiting these contracts cleanly while maintaining operational continuity requires legal and commercial expertise alongside the technical migration planning. Organisations that do not plan this contract transition explicitly and early consistently discover that contractual obligations to proprietary vendors constrain the pace of the open automation migration to a greater degree than any technical factor.

7. CONCLUSION

Open automation is not merely a technology transition for process industries it is a supply chain restructuring. The shift from proprietary DCS to O-PAS-compliant, IEC 61499-based software-defined control systems eliminates the single-source supply dependency that has defined process plant automation procurement for fifty years, creating competitive multivendor markets for control system hardware, engineering services, maintenance contracting, and spare parts that were previously captive to proprietary incumbent relationships.

The economic case is documented: 52% lifecycle cost reduction over 25 years, driven by the aggregate effect of competitive pricing across every supply chain dimension enabled by open architecture (Hoske, 2024). The ExxonMobil Lighthouse Project validates that these benefits are achievable at production scale. Moreover, the 2024–2025 procurement transformation data 40% reduction in manual workload, 35% of organisations with active supplier performance analytics, 74% of CPOs prioritising alternative supply source development demonstrates that the supply chain profession is developing precisely the capabilities that open automation supply chain management requires (Deloitte, 2025; Planergy, 2025).

The OSCA framework proposed in this review provides organisations with a structured five-stage model for aligning their supply chain practices with their open automation adoption maturity, ensuring that the supply chain transformation keeps pace with the technical migration and that the full economic benefits of open architecture are realised rather than left on the table through continued single-source supply practices in a technically open environment. The implementation challenges are real: supplier qualification complexity, procurement workforce development, and contract transition management all require deliberate investment. However, these are manageable engineering and commercial problems, not structural barriers. The structural barriers to supply chain transformation in process automation have been the technology itself. Open automation removes them.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest in the preparation or publication of this manuscript. Schneider Electric, a company active in industrial automation, employs Mohammed Hazique Shaikh. The views expressed in this paper are those of the authors and do not represent the official position of any employer or affiliated organisation.

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