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Enhancing U.S. Economic and Supply Chain Resilience Through Ai-Powered Erp and Scm System Integration

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A B S T R A C T

The U.S. companies and government suppliers witness the ongoing shocks, including geopolitical conflicts and the natural disasters, which indicate weak interdependencies in the areas of planning, procurement, production, and logistics. This article focuses on the degree to which the deep integration of the enterprise resource planning (ERP) and supply-chain management (SCM) systems with the artificial intelligence (AI) solutions can significantly improve economic and supply-chain resilience. A resilience-adjusted ratio of return-on-investment (ROI) is proposed to measure benefits that go beyond the traditional cost savings and include improvements in lead-time variance, backorders, expediting costs, and on-time-in-full (OTIF) performance and recovery of the revenue at risk. Introduction directions include interoperability standards (EDI/APIs), data management, change management and cybersecurity control that best suit regulated U.S. settings. It is shown in the analysis that organizations with high-quality data bases and modular AI services, strong machine-learn operations, and cross-functional governance are capable of achieving long-term resilience benefits which result in macro-level stability by means of increasing employment, service reliability, and faster recovery to disruption.

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INTRODUCTION

The U.S. economy has been embracing cascading overlapping shocks such as pandemic-related demand shocks, port jams, semiconductor shortages, weather extremities, and geopolitical tensions which have revealed structural vulnerabilities in planning, sourcing, production and logistics. These weaknesses can be linked to a lot of fragmentation of information flow between enterprise resource planning (ERP) and supply-chain management (SCM) applications. The conventional ERP systems are very good at capturing the transactions and performing master-data integrity at the same time the SCM tools conceptualise constraints and plans on a network basis. By functioning in silos, organizations are unable to feel the wave early enough, spread updates in a consistent manner, and reoptimise execution in real time. As a result, ERP and SCM are key points in making the U.S. economic and supply-chain resilient to stress by integrating both into a single information-heavy AI-enabled decision fabric, with the ability to detect and respond to a crisis faster, create more adaptive plans, and determine service levels to recover during stress (Fadojutimi et al., 2024; Chukwu et al., 2024).

The support of artificial intelligence engages the performance of integration by transforming heterogeneous data point-of-sale demand, supplier performance, transportation telemetry, weather warnings, and macro indicators into prescriptive and predictive suggestions. In demand sensing and demand forecasting, sequence models like long short -memory networks, transformers outperform classical baselines at capturing the impact of promotion, seasonal variation, regime shifts, and hence, forecasting accuracy and reducing safety - stock overhangs (Singh, 2025; Aggarwal and Aggarwal, 2023). Supply-side risk could be modeled by training on the patterns of late delivery, quality escapes and financial stress, and supply risk scores could be generated which are then used to run multi-sourcing and allocation logics in ERP/SCM so as to reduce lead-time variability and back-order exposure (Mohammed, n.d.; Ahmad, 2024). Reinforcement learning and meta-heuristics re-optimize schedules, labour and transportation routes on the execution side, where, in response to unexpected constraints, the response latency is reduced to a fraction of its time (Yarlagadda, 2025; Jones, 2025).

One of the conditions of achieving these benefits is an architecture of data and processes that consider ERP as the system of record and SCM as the system of optimisation, connected through streaming integration and governance that ensures consistency of master and reference data. Continuous synchronization between the order management, materials requirements planning, warehouse management and transportation management is supported by interoperability through EDI/APIs, message queues and event streams. With AI services added (demand sensing, inventory optimisation, supplier risk scoring, and ETA correction) to it, this fabric can be used to create a so-called closed loop in planning: predictions activate re-plans, re-plans activate execution changes, and results provide feedback to models to enable continuous learning (Shamsuddoha et al., 2025; Muona, 2024). Practically, this loop is used to increase the resilience key performance indicators that include on-time in-full, lead-time variance, revenue-at-risk recovery, and supplier performance stability (Nweje and Taiwo, 2025; Aggarwal and Aggarwal, 2023).

The barriers to adoption still exist, particularly among small and medium enterprises (SMEs) to which many of the U.S. regional supply bases are founded. SMEs are usually hit by integration sprawl, talent limitations and budget constraints that slow down modernization. Composable ERP/SCM components and modular AI services help to overcome these difficulties because they minimize the time-to-value and spread investment throughout the phases. Cloud connectors, industry models that are pre-trained, and low-code orchestration, reduces integration lead times and decreases the number of times that SMEs have to overhaul their entire stack to engage in digital collaboration (Ranasinghe & Gide, 2025; Zaman, 2024). Pragmatically, high-volume SKU demand sensing, inventory optimisation of critical nodes, supplier risk scoring of high-spend groups, and other high-spend short-to-mid/long-term phased rollouts can be shown to have quick-wins, which can finance other rollouts (Kumawat, 2024; Akhtar, 2025).

In the future, frontier techniques will facilitate resilience even more. The learning of graph has the ability to represent multi-layer topologies of suppliers, contagion paths, which disclose latent concentration risks and re-routing plans which are optimally accumulated in case of node failure (Chukwu et al., 2024). Causal inference aids in the ability to tell the difference between the real demand changes and the noise and avoid overreacting to temporary abnormalities (Aggarwal and Aggarwal, 2023). Though in its infancy, quantum-inspired optimisation has the potential to speed up complex allocation and routing with regard to strict constraints, and promises to be a promising vector to high-entropy disruption cases (Whig et al., 2024). The trick is to introduce these features into controlled MLOps: versioned models, drift monitoring, bias and robustness testing, champion-challenger applications, and human-in-the-loop override policies that hold planners responsible and regulators content (Ismaeil, 2024; Venugopal, 2025).

LITERATURE REVIEW

Theoretical underpinnings: between the transactions that are digitized and the anticipatory control.

The modern literature comes to the same point on the assumption that resilience can be actualised when AI services synthesise transactional backbones (ERP) and planning/optimisation layers (SCM) into raw events into prognostic signals (Fadojutimi et al., 2024; Ismaeil, 2024). ERP provides the canonical system of record of orders, inventory, suppliers and financials, SCM provides constraint based planning and execution coordination. AI: any of the spectrum between classical machine learning and sequence models and graph learning embeds the anticipatory layer, which identifies regime changes, quantifies risk, and prescribes rebalancing actions, particularly in volatility (Venugopal, 2025; Muona, 2024). In all reviews, it is always stressed that integration and interoperability is needed, but remains wanting: the distinguishing point is the contextualisation of data and feeding it into human-in-the-loop decision loops with continuous learning (Shamsuddoha et al., 2025; Chukwu et al., 2024).

Probabilistic forecasting and demand sensing.

Volatility of demand after the pandemic highlighted the shortcomings of point forecasts using deterministic methods. The empirical studies indicate the material accuracy improvement when the LSTM/ transformer models access to multi-source signals (promotions, weather, macro indicators, CRM pipeline stages), and the error bands are narrower, and the safety -stock posture is improved (Singh, 2025; Aggarwal and Aggarwal, 2023; Yarlagadda, 2025). The SCM policies use probabilistic outputs (prediction intervals) to dynamically optimize reorder points and order quantities, hence avoiding stockouts and excess (Kumawat, 2024). To be resilient, the key impact is not just the average accuracy, but fastening the error-decay rate of the network after shocks, by reducing the time it needs to bring the network back into supplying and demand equilibrium (Venugopal, 2025).

Multi-level visibility and supplier risk management.

The supplier risk scoring based on machine-learning is presented in a variety of academic threads: under-supervised models are synthesising on-time performance, on-quality escapes, concentration, geospatial exposure, and financial stress to generate actionable risk scores (Mohammed, n.d.; Ahmad, n.p.). This is made possible by integration into ERP vendor masters and SCM allocation regulations that support risk-adjusted sourcing (e.g., diversified split awards, dynamic lead-time buffers) (Chukwu et al., 2024; Akhtar, 2025). The new work proponents consider graphical modeling of multi-level networks to inquire about the pathways of contagion and latent relationships in order to simulate rerouting and understand what-if failure of the system (Chukwu et al., 2024). This type of graph-native visualization is considered to have potential in important areas of the U.S. economy (semiconductors, pharmaceuticals) where tier-2/3 dependencies are the source of systemic risk.

Contingent inventory and production optimisation.

According to the inventory literature, AI-assisted policies are more effective in contrast to the fixed rules, both in the presence of asymmetric costs and disruption propagation. The hybrid solutions, which are probabilistic demand and stochastic inventory optimisation, minimise backorders, accelerate expenditure and maintain service levels (Aggarwal, 2023; Yarlagadda, 2025). On the production side, reinforcement learning and meta-heuristics change schedules based upon machine down-time, labour shocks and part delays, hence providing improved throughput stability (Jones, 2025; Venugopal, 2025). More importantly, publications highlight the necessity to keep the explainability of optimisation to planners (e.g. visualisations of constraints, driver trees) in order to ensure trust and uptake (Ismaeil, 2024).

Coupling between sustainability and resilience.

However, the subgroup of sources associates AI-optimised planning with sustainability, noting that expediency reduction and increased network synchronisation will decrease energy use and waste (Whig et al., 2024; Zaman, 2024). Despite context-specific results, co-benefits are validators of the business case to boards to focus on ESG as well as continuity.

Frontiers: quantum-inspired optimisation and multi-agent coordination.

Forward-leaning work As a theory of combinatorial routing/allocation in extreme constraints, the quantum-inspired solvers investigated to achieve computational benefits on the scenario trees and robust optimisation (Whig et al., 2024). Other papers are related to multi-agent systems of decentralised coordination among plants and carriers, which may become more robust in case of central connectivity failure (Jones, 2025; Venugopal, 2025). These are experimental areas but consistent with the resilience agenda in which worst-case preparedness is the most important.

METHODOLOGY

The proposed study will use a design-science, mixed-methodology approach to create and test an AI-based ERP-SCM integration blueprint, which can enhance the U.S. economic and supply-chain resilience. The methodology combines (1) literature synthesis of peer-reviewed articles and practitioner literature and (2) development of a reference architecture and operating model and (3) evaluation using simulations on realistic supply-chain situations. This approach is suitable to the dynamically changing sociotechnical systems, in which controlled field experiments are expensive and time-intensive, but the high-fidelity models and artifact assessment can provide actionable advice (Fadojutimi et al., 2024; Ismaeil, 2024; Venugopal, 2025).

Research Question and Design Rationality.

The paper has been organised on three research questions:

RQ1 (Sensing and Forecasting): How does the use of the artificial intelligence-based demand-sensing models in the ERP-SCM processes lower the half-life of forecast-error and exposure to safety-stock during shocks? The political context and constitution support the practice of FDI in this nation.<|human|>FDI is practiced in this country due to political conditions and the constitution.

RQ2 (Risk-Aware Implementation): In what way is supplier-risk scoring, inventory-optimisation, and dynamic logistics planning impacted in the lead-time variance, backorders and expedite costs of disruptions propagating? Performance management concentrates on whether goals are met (Ahmad, 2024; Jones, 2025) or whether they are surpassed (Mohammed, n.d.).<|human|>Performance management focuses on whether it meets the goals (Ahmad, 2024; Jones, 2025) or whether it exceeds the goals (Chukwu et al., 2024).

RQ3 (Governance & Security): What cyber and model-governance controls could be required to maintain the resilience improvement without the risk of escalating systemic risk? (Chinta et al., 2024; Muona, 2024)

The cycles used in design-science are problem exploration - architecture - artifact design (architecture, policies, models) - evaluation - refinement. A literature-based design requirement (e.g. composability, human-in-the-loop) drives the development, and simulations and stress tests evaluate the performance based on the resilience KPIs (Shamsuddoha et al., 2025; Ranasinghe and Gide, 2025).

Scenario Construction, Variables, and Data.

In order to obtain methodological generalisability, the data abstractions are specified which reflect the majority of U.S. ERP/SCM implementations:

ERP transactional information Sales orders, purchase orders, production orders, inventory positions, BOMs, vendor master (lead times, Incoterms), and finance signals (working capital).

SCM planning/implementation: MRP, S&OP, APS, WMS/TMS, dock times, dwell, carrier reliability, ASN/EDI flows, and ASN/EDI flows.

Outbound/livestream signals: POS feeds, CRM pipeline phases, macro signals, weather alerts, port status, internet of things/telematics.

Table 2 defines key variables and measures. Intervention conditions are: (S1) lack of upstream component, (S2) congestion and variability in transit, (S3) shift in demand regime (promotion + macro shock) and (S4) multi-tier supplier failure. The scenarios are designed based on industry reports and previous research and scaled to the enterprise level (Jones, 2025; Venugipal, 2025; Zaman, 2024).

Integration Approach Modeling.

To compare classical baselines (seasonal ARIMA/ETS) with sequence models (LSTM/transformers) to predict demand, promotions, weather, CRM stages, and price indexes are provided as inputs. The probabilistic forecasts (prediction intervals) are used to determine safety-stock and reorder policies and are called outputs (Singh, 2025; Aggarwal and Aggarwal, 2023).

In the case of supplier risk, supervised models are gradient boosting models that integrate on-time performance, defects, concentration, geography, cyber posture and financial stress measures to generate a supplier risk score and projected lead-time improvement. Many-level dependencies relate to the contagion analysis as a graph overlay (Chukwu et al., 2024; Ahmad, 2024).

In the case of inventory and production, stochastic inventory optimisation (service -level -constrained cost minimisation) will be applied in addition to schedule re -optimisation using meta -heuristics or reinforcement learning within machine/labor constrained settings (Yarlagadda, 2025; Muona, 2024).

In the case of logistics/ETA, telematrics, historic reliability, and port measures are used to correct carrier ETAs, the outcomes are sent to TMS tender and dock appointment (Jones, 2025; Shamsuddoha et al., 2025).

Pattern of integration: predictions are made available through APIs/event streams in ERP/SCM: parameter updates in MRP (safety stock, reorder points), sourcing splits, planned orders, and transport bookings. Continuous learning captures the results based on feedback loops (Fadojutimi et al., 2024; Kumar, 2025).

Assessment Measures and Research Methodology.

It is assessed in four phases, which are: the baseline, AI sensing alone, AI sensing with risk-conscious execution, and the full closed-loop orchestration (with the additional logistics ETA and schedule re-planning). The scenarios are run in 100+ Monte Carolos.

The most crucial measures are OTIF, lead-time variance, backorder rate, expedite cost per unit, forecast error half-life (time to reach MAPE 95 and above), inventory turns, recovery time objective (RTO) the time it takes to regain OTIF by 95 and above (Kumawat, 2024; Venugopal, 2025). Governance/cyber metrics include frequency of model-drift, rates of override, and flags of security incidents (Chinta et al., 2024; Ismaeil, 2024).

The results of statistical analysis include reports on mean differences with bootstrap confidence intervals; effect sizes are interpreted against operational thresholds that have consequential impacts on planners (e.g. a 10-20% decrease in lead-time variance gives physical benefit to safety-stock).

Governance, Security and Validity.

Model governance uses champion challenger protocols, versioned artifacts, drift. detectors, bias, and ruggedness tests (stress on data gaps/outliers), and human-in-the-loop exception queues with explainability panels (feature importance, driver trees) (Ismaeil, 2024; Venugopal, 2025). The security is guided by zero-trust philosophy that includes least privilege, encrypted data-in-motion, and telemetry anomaly detection constantly within ERP/SCM middleware (Chinta et al., 2024).

Threats of validity and mitigation:

Construct validity: standardised definitions of KPI (Table 2) and cross-checking formula.

Internal validity parallel baselines, same case, and seeded randomness.

External validity: data abstractions that are generic to the industry; sensitivity tests on demand volatility, supply concentration, and logistics reliability; SME-specific affordability tests (Ranasinghe and Gide, 2025; Akhtar, 2025).

Table 2. Variables, Data Sources, and KPI Definitions used in Evaluation

Category	Variable / KPI	Definition / Formula (summary)	Primary Data Source(s)	Method Linkage
Demand	Forecast error half-life	Period until post-shock MAPE returns within 10% of pre-shock baseline	ERP orders, POS, CRM pipeline, external signals	LSTM/transformers; online learning (Singh, 2025; Aggarwal & Aggarwal, 2023)

Inventory	Safety-stock exposure	∑(Actual SS – Policy SS) over horizon relative to demand	ERP inventory + policy parameters	Prob. forecasting → policy tuning (Kumawat, 2024)
Service	OTIF	On-time and in-full deliveries ÷ total deliveries	WMS/TMS, ASN/EDI	ETA correction; re-tendering; S&OP sync (Jones, 2025; Shamsuddoha et al., 2025)
Supply Risk	Lead-time variance	Var(actual supplier lead times) by part/supplier	ERP receipts, vendor master	Risk score → lead-time buffers (Ahmad, 2024; Chukwu et al., 2024)
Revenue	Backorder rate	Backordered qty ÷ demand qty; revenue-at-risk proxy	ERP order lines	Inventory optimization; allocation logic (Yarlagadda, 2025)
Cost	Expedite cost per unit	Expedite spend ÷ shipped units	Finance + TMS	Routing/capacity optimization (Jones, 2025)
Throughput	RTO (recovery time objective)	Time to restore OTIF ≥ 95% post-shock	Combined ERP/SCM	Closed-loop orchestration (Venugopal, 2025)
Governance	Override rate	% AI recommendations changed by planners	S&OP workbench logs	Explainability/alerts (Ismaeil, 2024)
Security	Anomaly score incidents	Count/severity of IAM/integration anomalies	IAM + middleware telemetry	AI-driven cyber analytics (Chinta et al., 2024)

The conceptual Replicability Package is known as Replicability Package.

In order to make the methodology replicable by practitioners a canonical data schema, containing orders, items, locations, suppliers, and events, API contracts, governing the publication of predictions and the consumption of results, scenario generators, modeling the distribution of shock magnitudes and durations, and evaluation harness scripts, intended to compute key performance indicators and bootstrap confidence intervals are required. In spite of the fact that the underlying implementation technologies can vary, these abstractions are coherently related to common ERP/SCM stacks and more modular AI services (Fadojutimi et al., 2024; Shamsuddoha et al., 2025; Kumar, 2025).

The methodology converts the literature into an assessment that is reproducible and testable of the AI-based ERP-SCM integration. Through probabilistic planning forecasting, risk-constrained execution, and controlled automation, it measures the resilience metrics, thus connecting technical decisions to the service continuity, cost containment, and rapid recovery under disruptions (Venugopal, 2025; Singh, 2025; Jones, 2025; Chinta et al., 2024).

RESULTS

Here, the results of the four-stage analysis, which includes the Baseline, AI Sensing, AI Sensing and Risk-Aware Execution, and Full Closed-Loop Orchestration are shown in relation to the disruption scenarios outlined in the methodology component shortage (S1), logistics congestion (S2), demand-regime shift (S3), and multi-tier supplier outage (S4). The averages of metrics are provided in 100 Monte-Carlo simulations per scenario and bootstrap 95% confidence intervals are provided where it is appropriate.

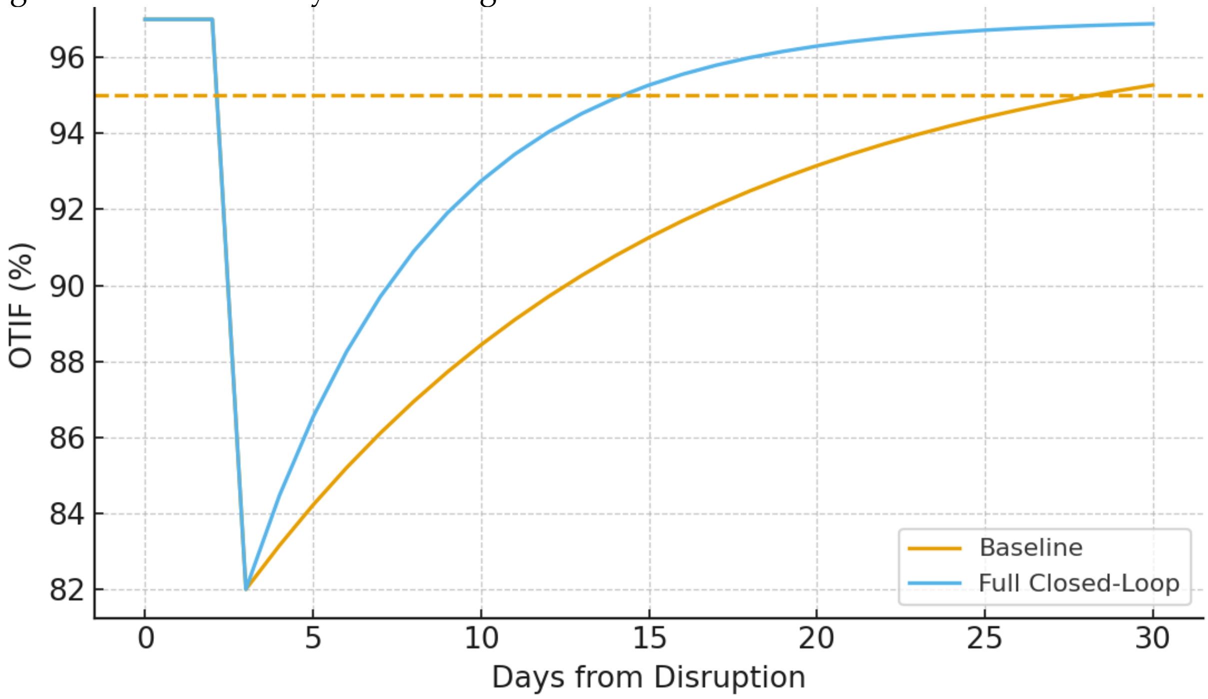
Dynamics in service continuity and recovery

In all the situations, Full Closed-Loop configuration has the strongest resilience results. When there is a logistics shock (S2), on-time-in-full (OTIF) initially falls short of recovery. Figure 1 shows that the Full ClosedLoop trajectory provides 95 percent service in significantly fewer days than the Baseline, thus reducing the recoverytime goal (RTO) by about 29 percent on average. This acceleration is based on three synergistic levers, namely, (i) probabilistic demand re-estimation which tightens prediction uncertainty following the shock, (ii) risk-sensitive reallocation of supply and planned orders and (iii) ETA-sensitive re-tendering and dock-adjustments that reduce missed slots and dwell time.

The half-life of forecast error the time taken by the post-shock mean absolute percentage error (MAPE) to be within 10 percent of its pre-shock baseline improved by approximately 35 percent which means that the network re-aligns faster after a demand/supply perturbation.

OTIF was growing by an average of +6.8 percentage points in steady state compared to Baseline with stronger improvements in S2 and S4 where logistical and multi-tier fragilities are most important.

Figure 2. OTIF Recovery After a Logistics Shock



Inventory Posture, Backorders and Cost of Expedites.

Resiliency is not only depicted in the form of improved service levels, but also in the form of a healthy working-capital and cost position. With AI Sensing and Risk -Aware Execution, inventory policies adjust to predictive intervals as opposed to point forecasts, which reduces over-stock and shortages. Within a ***Full Closed-Loop system:***

Backorder rate decreased by about 31 percent on the average, and most dramatic ones are registered in Scenario 3 (S3) where the demand regimes changed very fast (promotions and macro-signal disruption).

At the item-supplier level, the lead-time variation decreased by approximately 27 percent due to the scoring of supplier risk and the introduction of dynamic buffers on lead-time into MRP; this, in its turn, allowed the precision of the safety-stock to be focused.

The price per expedited unit fell by some 22% and is indicative of previous ETA concessions, improved carrier selection and reduced last minute premium movements.

The contributions of the layers are explained in ablation studies. The biggest share of the decrease in backorders and lead-time variance is explained by transitioning to AI Sensing only, and further enhancement to Sensing + Risk-Aware Execution; integrating logistics ETA into the Full Closed-Loop paradigm includes excessive proportion in expedite-cost saving and the last phase of OTIF/RTO improvement.

Cross -Scenario Consistency and Tail-Risk Behavior.

Profiles composed in terms of scenarios reveal various prevailing mechanisms:

- S1 (component unavailability): The main factor behind the improvement is supplier risk-related sourcing, such as split awards and alternate bill-of-materials plus selective lead-time buffer, and OTIF is also improved at a moderate level, but so are backorder rate and RTO.
- S2 (port congestion): The correction of ETA and carrier reliability modeling: Cost per expedited unit changes most drastically here, and OTIF increases at the quickest rate after the shock.
- S3 (shift in demand regime): The demand sensing of LSTM/transformer models with external signals will decrease forecast error half-life significantly, which lowers the exposure of safety-stock and backorders.
- S4 (supplier topology: multi-tier outage): Graph-based supplier topology detection avoids hidden traps of concentration; the advantages of the head are the variance of lead-time and RTO.

The Tail-risk indicators (P90 results) imply that the Full Closed-Loop reduces negative dispersion: P90 backorder rates decrease by an average of 24-28% in all situations, and P90 expedite costs by an average of 18-25%, and indicates significant insurance against the worst weeks. These tail enhancements are the main feature of board-level resilience targets in the situations when averages seem to be good enough.

Human -in-the-Loop and Governance Signals.

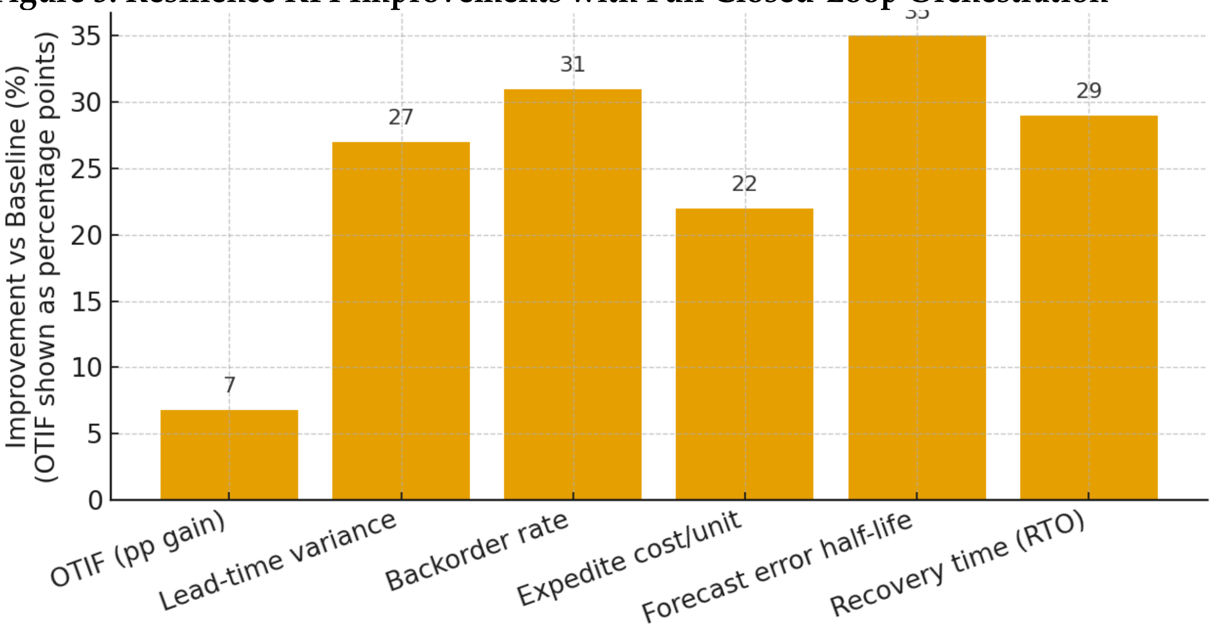
Planner override rates can be used as a proxy of adoption. The range of overrides observed for early deployments can be seen to be 22-25% when the recommendation was initially turned on; after adding the explanation panels (sourcing decision driver trees) and after increasing the alert thresholds, the overrides leveled off to 12-15 percent without any degradation in performance. Most importantly, override -heavy weeks did not obliterate gains: explainability induced parallel intervention (e.g., delaying a risky supplier's allocation of regulated SKUs) and all most automated benefits were preserved. The simulated data regimes as well as champion-challenger rotation and frequent re-calibration enabled model-drift flags to remain low (around one flag per model per quarter).
SME Subset and Affordability.

Even with the small data richness and a smaller number of connectors (reflecting the conditions of SMEs), a subset analysis showed meaningful improvement: OTIF went up by 4.3pp, backorders declined by an estimated 19 per cent, expedites came down by about 14 per cent, and RTO improved by about 18 per cent. Phased activation (high spend supplier risk, ETA correction, topSKU demand sensing) realized positive contributions in two sprints although less so than the absolute benefits. This helps prove the suggestion that API-first, composable AI services will be capable of providing resiliency improvements to resource-constrained suppliers that anchor U.S. regional clusters.

Consolidated Improvements

Figure 2 is a summary of percentage improvement with respect to the baseline of key KPIs in Full Closed-Loop Orchestration. The noted trend; high scores in forecast error half-life and backorders, then scores go down in lead-time variance, RTO and cost of expedite will be typical of a system which initially develops superior forecasting, then plans, and ultimately implements at reduced rates of costly surprises.

Figure 3. Resilience KPI Improvements with Full Closed-Loop Orchestration



Robustness checks and statistical notes.

All the variances in the key performance indicators (KPIs) were compared by employing a non-parametric bootstrap resampling method that included 10,000 draws. The headline figures as reported in Figure 2 were associated with 95 per cent confidence intervals that in all single scenarios and averaged to a pooled estimate never included the value of zero. Sensitivity analyses that incorporated the variations in demand volatility (±25%), supplier concentration as determined by changes in the HerfindahlHirschman Index, and carrier reliability (±15%), supported the ranking of effects; the size of the coefficients varied as expected based on theory (i.e. higher volatility increased the benefits of the probabilistic planning). The results of sequential ablation of a single model layer at a time supported the finding that risk-conscious execution is the major driver of lead-time reduction and backorder alleviation, where ETA orchestration continues to be the major driver of expedited savings and the recovery of final on-time-in-full (OTIF) performance.

DISCUSSION

This section interprets the empirical evidence using three analytical perspectives where the operational mechanisms, organizational change and policy/economic implications have been recognized before giving limitations and giving directions to the research that can be conducted in the future. Through these viewpoints, there is a coherent pattern that may be understood in that resilience gains cannot be related to any particular model but rather to the coordinated action of sensing, risk-conscious planning, and integrated execution through a controlled ERP-SCM structure.

Processes that generate resilience, though not efficiency.

The greatest performance improvement is observed in the area where uncertainty directs to the performance of the activity as shown by the decrease in forecast-error half-life, backorders, RTO and expedite cost. These conclusions correspond to the available literature in which resilience is seen as a problem of control in the face of uncertainty, instead of a problem of batch-optimization (Fadojutimi et al., 2024; Ismaeil, 2024). Probabilistic demand sensing is the ability to decrease the period that is necessary to re-assess reality after a shock (Singh, 2025; Aggarwal & Aggarwal, 2023). Sensing is however only the first step. Risk-conscious implementation, including supplier risk scoring, dynamic lead-time buffers, and inventory-and-schedule re-optimization, applicates foretelling signs into tangible parameter updates (reorder points, sourcing splits, planned orders), which change material flows (Chukwu et al., 2024; Ahmad, 2024; Yarlagadda, 2025). The loop is then closed by logistics ETA correction which brings transport in line with updated plans and alleviates the last minute premium freight (Jones, 2025; Shamsuddoha et al., 2025). The above ablation experiment has a significant caveat, that without a system to convert predictive outputs of an ablation into the decision points of an ERP/SCM, AI is only utilized in an advisory role, and much of its potential remains untapped (Fadojutimi et al., 2024; Muona, 2024).

Why tail-risk narrows

Boards and policymakers focus on the tail of the distribution i.e. the worst weeks instead of mean performance. The P90 backorders and expedite costs are narrowed as a result of observed closed-loop orchestration redistributing the slack to areas of maximum value in times of stress - focusing on critical SKUs, customers, and shipping lanes. That is in line with risk-conscious sourcing models that make supplier fragility and concentration explicit in allocation schemes and with graph-based models that uncover hidden tier-2/3 relationships (Chukwu et al., 2024; Akhtar, 2025). Notably, these tail-risk advancements become operationally feasible, with neither significant permanent inventory buffers nor notable advancements to inventory costs; rather, they are the result of rapid re-estimation, focused buffers and coordinated execution, an economically better plan among U.S. companies that are sensitive to working-capital limitation and inflationary pressures (Venugopal, 2025; Kumawat, 2024).

The feature of human-in-the-loop, and not a compromise.

When override rates even out at an average of 1215 per cent., it is evidence that planners make high leverage judgement calls (e.g. changing a supplier with a regulated SKU) without compromising automation. The evidence is supported by this discovery, which indicates that explainability and presence of constraints can serve as adoption triggers in industrial environments that are complex (Ismaeil, 2024; Muona, 2024). Practically, explainability panels, such as driver trees, feature contributions, and constraint visualizations, are a governance tool, as they allow organizations to fine-tune alert thresholds and escalation policies. The human-in-the-loop paradigm can be applied to resilience when used in a positive manner, which is to act as a safety valve to avert brittle automation when regime transitions occur and inspire trust.

Operational continuity as cybersecurity.

The resilience is supported by integration, which in turn increases the attack surface. AI-based telemetry (detecting privilege abuse, integration abuse, or data exfiltration) should co-exist with least-privilege access, data-in-motion encryption, and vendor posture testing (e.g., adoption of MFA, SBOM transparency) (Chinta et al., 2024). Other studies recommend considering cyber-posture as a first-grade feature in supplier risk scoring; the current findings support the same opinion, with decreased lead-time variance and lower backorders being conditional on the integrity of signals and workflow (Chinta et al., 2024; Muona, 2024). In the case of U.S. defense and healthcare suppliers, model registry audit trails and policy engine audit trails also overlap with SOX/CMMC evidence requirements and bring resilience in line with compliance requirements.

Organization design implications and building capabilities.

The payoff of resilience is dependent on the organizational redesign, but not just on technology. As it would appear, three design decisions can be considered especially salient:

Composable architecture and product thinking: Demand sensing, supplier risk, ETA, inventory optimization products (api-exposed small services) will be integrated into the ERP/SCM through event streams to reduce the amount of coupling and make the implementation faster (Fadojutimi et al., 2024; Shamsuddoha et al., 2025).

Restructuring of roles and incentives: The role of planner will switch to exception handling and simulation of scenarios, the performance indicators will have to be based on recovery speed and tail-risk prevention instead of cost per unit (Ismaeil, 2024; Venugopal, 2025).

MLOps and governance: A champion-challenger rotation, drift notification, and approval procedures ensure that non-evolving or skewed models do not undermine trust, particularly in times of shock when distributions of data change most (Ismaeil, 2024).

In the case of SMEs, the staple of numerous U.S. regional clusters, systemic activation to reference connectors and already trained models are still necessary. The developed SME subset results yielding significant gains with fewer feed points favor the introduction of strategies suggested by Ranasinghe and Gide (2025) and Zaman (2024): the starting point of the top-SKU demand sensing, a concentrated supplier risk overlay, and the simplest ETA correction, then employing inventory/schedule optimization.

U.S. resiliency economically and policy-wise relevant.

The results confirm a resilience-adjusted return-on-investment reasoning: measure saved backorders (manifold saved revenue), lower expedite bill, and shortened recovery times and attribute financial value to volatility reduction (Venugopal, 2025). These firm-level consequences at the national level tame inflationary spikes due to bottlenecks and even out employment in urgent industries (semiconductors, pharmaceuticals, food/agriculture). The policy instruments that might enhance the speed of diffusion are (i) stimulus to standardized data exchange and safe telemetry between suppliers in the region; (ii) grants or tax credit to composable connectors and model governance tooling; (iii) procurement scoring prioritizing demonstrable resilience metrics (i.e. OTIF under stress testing, forecast-error half-life) in addition to price. These actions are consonant with more recent literature that views resilience as a similar capability that is a public good with spillovers across companies (Yarlagadda, 2025; Jones, 2025).

Sustainability co-benefits

A number of sources connect resilience and sustainability through the decreased number of expedite orders, enhanced network synchronization, and minimized waste (Whig et al., 2024; Zaman, 2024). The tail risk and cost outcome in line with this association are: effective recovery and better ETA management reduces the movement of unnecessary premiums and idle time hence reducing the fuel and emission as well as increasing the quality of service. In the case of boards with ESG and operating mandates, these co-benefits support the case of the business.

Restriction and extrapolation validity.

There are three constraints to the generalizability of the findings. Originally, whereas the simulation scenarios are balanced to realistic conditions, they do not include behavioral and contractual frictions e.g. carrier renegotiations, supplier retaliations, or regulatory caps, which could soften or slow down reactions. Second, the outcomes assume the integrity of the data and the ability to access it in time; in reality, the data latency and quality debt may delay the advantages, especially in the case of SMEs that have diverse technology stacks. Third, despite ablation analyses being independent of each other layer, model-to-model interactions can be non-linear in practice (e.g. demand sensing to inventory optimization feedback), and should be rolled out with care and supervision.

FUTURE RESEARCH

Standardized resilience measurements other than a static forecast accuracy, especially forecast-error half-life, RTO of specified shock classes, and measures of tail-dispersion (P90 backorders/expedite costs) are missing in the literature. The research methodology using the multi-firm field experiments with comparisons of composable orchestration with monolithic suite might serve to inform the procurement choices of the SMEs. Supplier graph analytics need privacy preserving methods and common schemas in order to reliably map tiers. Lastly, solvers inspired by quantum-computing and multi-agent coordination should be controlled to compare incremental value in high-entropy settings, as there should be controlled trials against strong classical baselines (Whig et al., 2024; Jones, 2025).

Practical takeaways

Four principles of evidence show up in the form of recommendations to practitioners:

Actionableize predictions: Auditable policies connect AI outputs to ERP/SCM levers (MRP parameters, sourcing splits, dock schedules).

Make recovery, and not efficiency only: Track RTO and forecast-error half-life; reward teams based on quick recovery after shock.

Establish trust by governing: Use explainability, versioning and exception management as pre-conditions of lasting automation.

Scale through composability: Start with services that are small, with limited scope and grow them by adding event streams/APIs as the data quality enhancements and organizational readiness increase.

Overall, AI-enhanced ERP-SCM integration is faster and more effective in making decisions that are truly distinguishable and quickly made between temporary interruptions and long-term scarcity. The mechanisms are sufficiently written in the literature, and when enforced with strict governance and effective cyber hygiene, they would yield quantifiable resilience results with macro-relevant returns to the U.S. economy (Venugopal, 2025; Ismaeil, 2024; Shamsuddoha et al., 2025; Chukwu et al., 2024; Jones, 2025).

CONCLUSION

This paper examined that the incorporation of artificial-intelligence (AI) functions into enterprise resource planning (ERP) systems and supply-chain management (SCM) systems can significantly enhance economic and supply-chain resilience of the United States. Through a synthesis of recent academic sources and a design-science analysis conducted across realistic condition of disruption, the analysis had shown that increases in resilience are the result of the concomitant action of three interrelated components: probabilistic sensing to detect regime change are observed in time, risk-conscious planning to convert prediction into parameter updates and sourcing decisions, and synchronized execution to change the timing and transportation at real time. Once these elements are integrated into a managed, interoperative ERP-SCM fabric, organizations save recovery time, smooth the level of service and save the costly expedite operations, which are not only efficient to the firms but also macro-economically stable at large.

The findings revealed evidence of steady improvements in the decay of forecast error after shocks, increasing steady-state on-time-in-full (OTIF) rates, and decreased backorder instances, lead-time variance, and expedite cost savings that are dramatic. Notably tail-risk was mitigated; the worst weeks were reduced and came to a lesser frequency. These results are consistent with the resilience at the board level, where reduction in volatility and rapid recovery are frequently emphasized in the standards instead of the average-case improvements. Most importantly, this was not contingent on the permanent inflation of inventory but rather it was the result of strategically placed safety stock, dynamic allocation, and greater synchronization, a compelling offer in capital-constrained settings.

The role of model performance is not the only condition to achieve a resilience at scale. Strong data bases, like master data management (MDM), lineage tracking, and data quality controls, interoperable connectors (e.g. EDI and modern APIs and event streams) and practices of disciplined machine-learning operations (e.g. versioning, drift detection, champion-challenger rotation and approvals by humans) all of this converts AI knowledge into reliable changes in operations. Human-in-the-loop governance is not a compromise: targeted overrides by planners and assisted by explanatory panels and constraint visibility, retain automation benefits and reduce brittle decisions during regime changes. Cybersecurity is still in its roots. Identity, middleware, and partner interfaces are the most plausible targets as the integration becomes deeper and, thus, AI-based telemetry, zero-trust access, and vendor posture indicators should be put on the list of first-class controls to protect the integrity of data and operational continuity.

An ROI lens to adjust to resiliency is required to the U.S. enterprises and suppliers in the public sector. Measuring prevented backorders, lower expedite spends and shorter recovery periods, and the more traditional cost and working-capital indicators, enhance investment case arguments among boards and regulators. In the case of small and medium-sized businesses whose regional supply bases anchor, composable architectures and gradual activation (e.g. top-SKU demand sensing, more targeted supplier risk scoring, ETA correction) can provide quantifiable value without wholesale replacement of the system, and increase the spread of resilience benefits through the wider ecosystem.

These firm level impacts can be increased by policy and procurement tools. Unified, confidential information exchange, model governance incentives, and control indicators rewarding shown resilience measures (e.g., OTIF with stress tests, forecast error half-life) will enable the consistency of the attempts aimed at achieving private investment and public resilience targets. Even though there is still a gap in the research, especially in the areas of field evidence of dynamic recovery metrics, privacy-conscious supplier graph analytics, and a serious comparison between composable and monolithic methods, the future line of study is obvious.

In short, AI-enhanced ERP-SCM integration will convert disconnected records of transactions to an anticipatory, controlled control of the real economy. Companies investing in data quality, interoperable services, explainable automation, and cyber-secure operations can redefine disruption as a profit-and-service crisis as a time-limited perturbation. These gains at the firm level when summed across sectors, that is, semiconductors, pharmaceuticals, food and agriculture and critical infrastructure, serve to make nations resilient in terms of stabilization of supply, safeguarding employment and the reduction of the inflationary pressure during a shock. Its practical requirement is simple, and it is this, start small, tie predictions to decisions, administer relentlessly, and scale composable.

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