PES UNIVERSITY ISA CAPSTONE PW26_RGP_01

# Immunological Supply Chain

A supply chain that heals itself the way an immune system does. Statistical anomaly detection is the innate layer. A graph encoder, a recovery model and a reinforcement learning router are the adaptive layer. A FAISS index of past disruptions is the memory. This page is a static snapshot of the committed results. The full interactive dashboard is a separate live Streamlit app, linked from the portfolio.

## HEADLINE RESULT

**71%**

Win rate: planner's vendor pick beat actual procurement on late rate in 54 of 76 comparable cases (95% CI 61 to 80%). 13 ties, 9 losses.

**4.0%**

Late rate of the recommended vendors against 18.0% for the vendors procurement actually chose. Gap 14.0 points (95% CI 9.9 to 18.0).

**0.90**

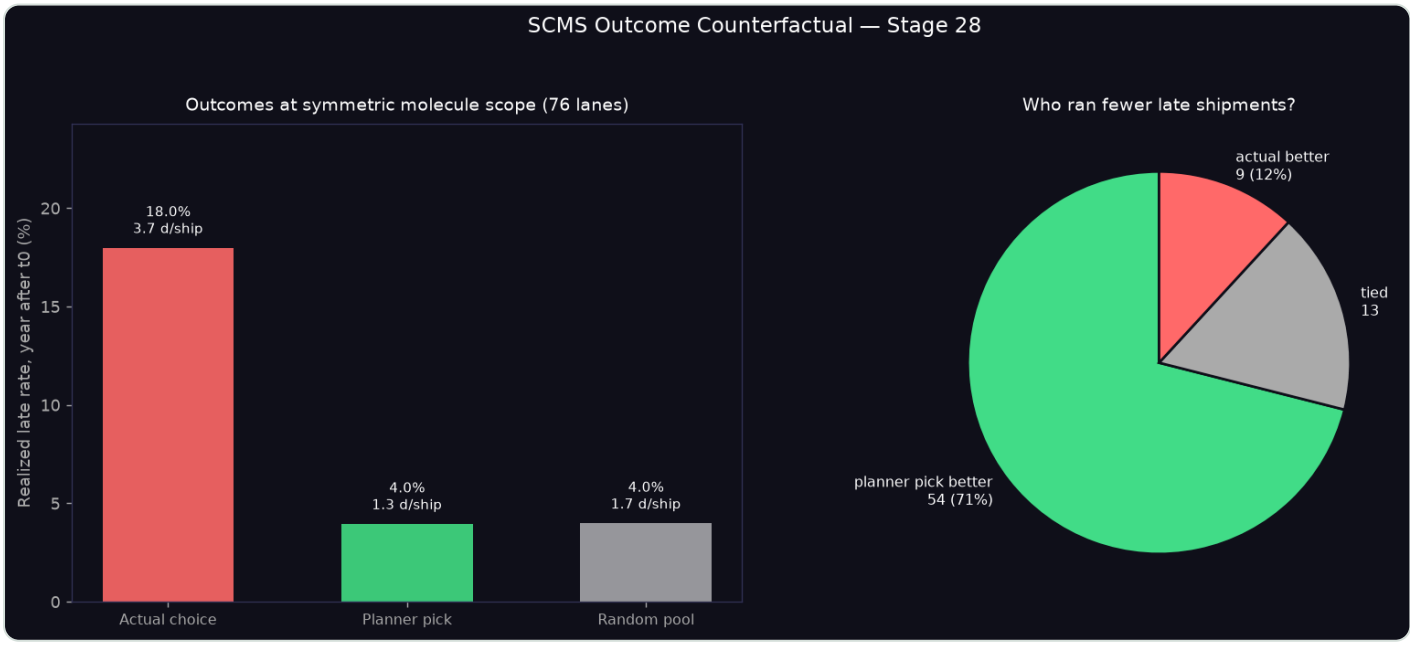
GNN AUC on injected-anomaly benchmark (4 seeds, std 0.017). Best baseline 0.80.

**28**

Pipeline stages, run from one command over any transaction level dataset.

## COUNTERFACTUAL ON REAL USAID SHIPMENTS

For each comparable procurement decision, the planner's pick is compared with the vendor that was actually used. The sign test gives p = 6e-9.



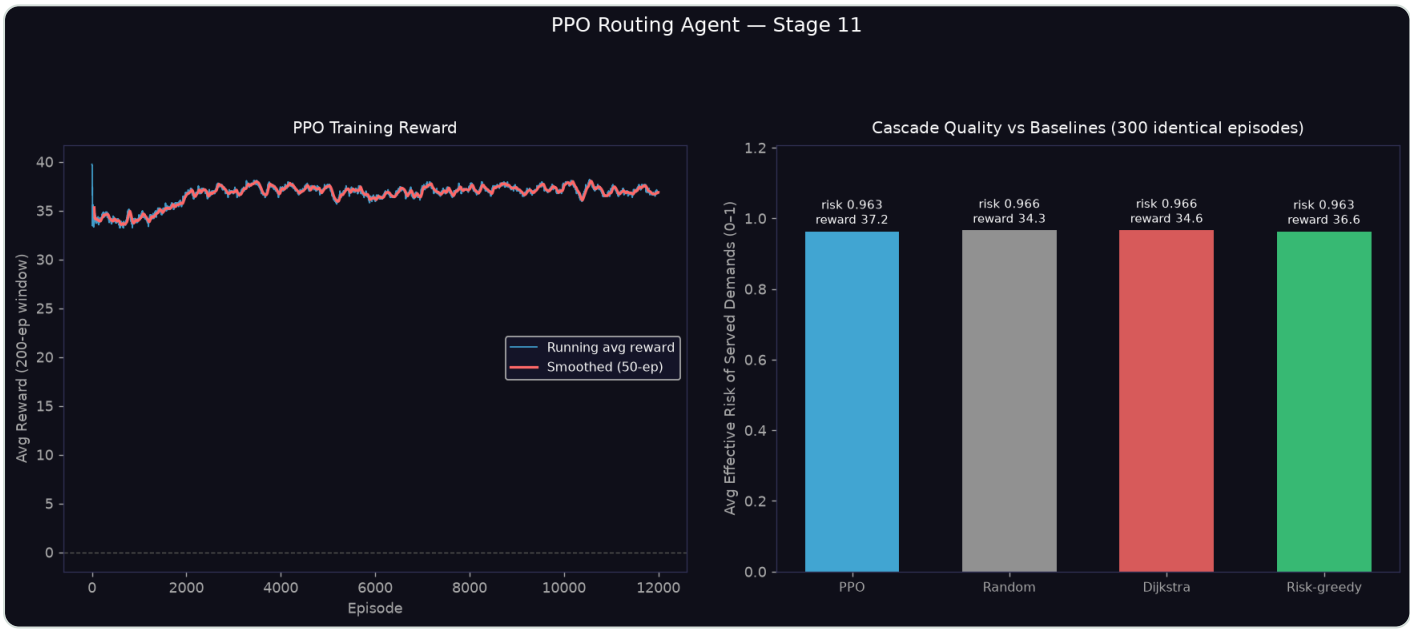

Stage 28, SCMS outcome counterfactual.

## PPO REROUTING UNDER A DISRUPTION CASCADE

Evaluated on held-out disruption sites only, 300 episodes, four policies.

| POLICY | MEAN REWARD | UNSERVED |
|---|---|---|
| PPO | 37.2 | 28 |
| Risk-greedy | 36.6 | 35 |
| Dijkstra | 34.6 | 56 |
| Random | 34.3 | 60 |

> PPO clearly beats Dijkstra (paired reward gain 2.5, 95% CI 1.4 to 3.7). Its edge over the load-aware greedy heuristic is not statistically significant (0.6, CI -0.4 to 1.6), and the anchor-level cluster interval is wider still. The report says so rather than claiming a win.




Stage 11, PPO training.

## MACRO STRESS AGAINST FIVE DOCUMENTED CRISES

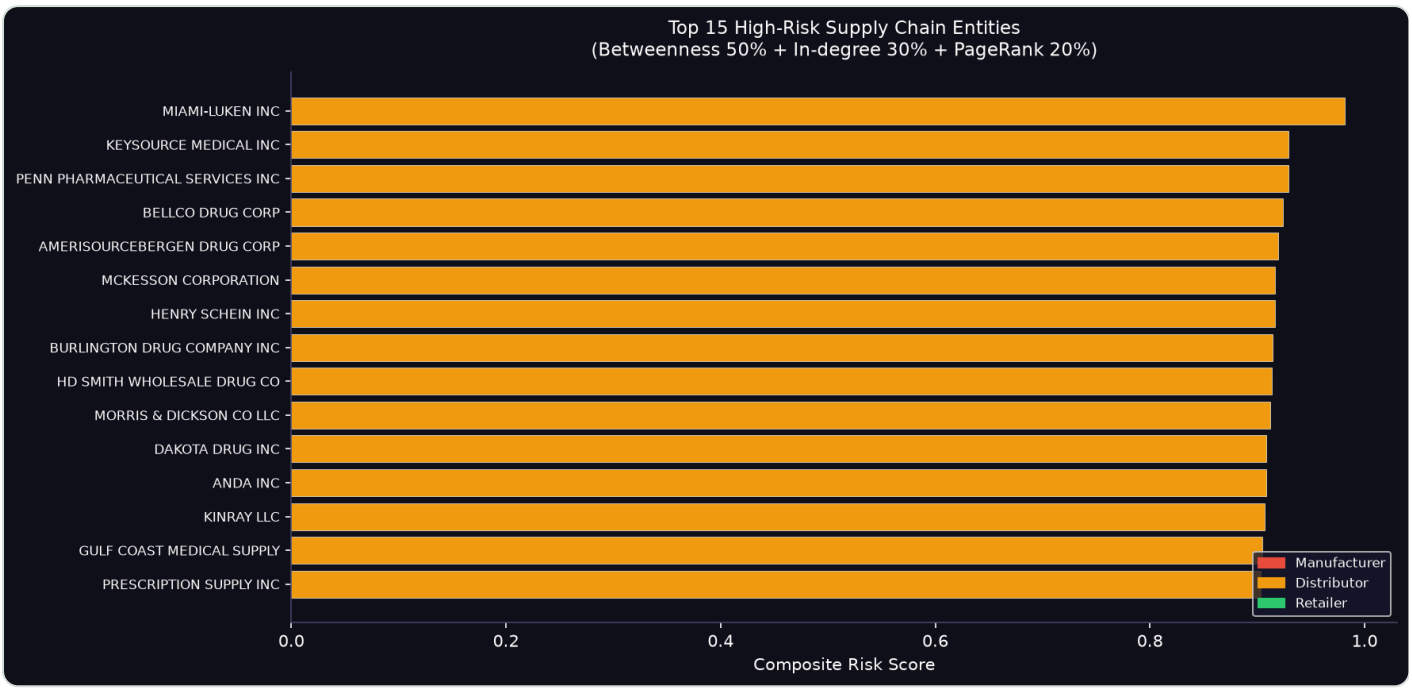
The freight stress composite uses no look-ahead: each indicator is ranked against its own history up to that week. Verdicts at the 52 week burn-in:

| EVENT | VERDICT | TOP DRIVER |
|---|---|---|
| Suez Canal blockage | Detected | Diesel prices |
| Red Sea shipping attacks | Detected | Freight transportation |
| COVID-19 onset | Not seen | Inventory to sales |
| US port congestion peak | Not seen | Inventory to sales |
| Russia invades Ukraine | Not seen | Inventory to sales |




Stage 27, macro crisis validation.

## HIGHEST RISK ENTITIES




Stage 4, centrality based risk.

## RUN IT

Code, tests and the full dashboard: [github.com/arch-vvc/immunological_supply_chain_management](github.com/arch-vvc/immunological_supply_chain_management). Numbers on this page come from `output/RESULTS_MANIFEST.json` in that repo.