Operations-Driven Analytics in E-Commerce

First Approach

Source: Unsplash

Loris Emanuelli
Capstone Projects 121 & 122 (2025–2026)

Today's Journey

1. Set the opening scene and objectives
2. Link analytics to operations leverage
3. Surface review paper takeaways
4. Demystify the Newsvendor logic
5. Map relevance, gaps, and risks
6. Align on datasets, next moves, and discussion

Source: Unsplash

Responsive Inventory in Motion

Mišić & Perakis (2020) document how retailers fuse POS, clickstream, and supplier telemetry to shrink the latency between demand sensing and replenishment. Their case analyses show safety-stock reductions of 15–25% once inventory targets refresh with real-time signals across stores and DCs.

Signals Highlighted in the Review

- SKU-level velocity forecasts updated from streaming data
- Reverse logistics information feeding net-demand estimates
- Supplier reliability scores guiding multi-echelon positioning

Last-Mile Orchestration

Control Tower Actions

- Predict route saturation by lane and time window
- Re-sequence stops when telemetry flags bottlenecks
- Sync promised slots with capacity forecasts

Analytics Payoff

The review cites same-day pilots in North America and Asia where integrating vehicle tracking, order forecasts, and workforce data trimmed late deliveries by 12–18% while containing surge labor. These examples underscore the value of feedback loops that tighten the promise-to-fulfillment cycle.

Mišić & Perakis (2020), Section 3.4

Revenue Management Playbook

Mišić & Perakis (2020) argue that revenue analytics succeeds when pricing, assortment, and inventory share a common demand backbone. They highlight e-commerce cases where Bayesian or reinforcement learning models update price ladders daily while honoring inventory guardrails.

1. **Dynamic Pricing:** Learning-based engines respond to elasticity signals while preserving minimum inventory buffers.
2. **Assortment Tuning:** Stochastic programs allocate digital shelf space across substitutes using margin and supply risk inputs.
3. **Targeted Promotions:** Uplift models prioritize segments that marketing can serve without overwhelming fulfillment capacity.

Mišić & Perakis (2020), Sections 4.1–4.3

Newsvendor Intuition

"The single-period inventory problem is a balancing act between disappointing customers today and holding excess stock tomorrow. The Newsvendor model quantifies that trade-off so planners can align service levels with risk tolerance."

- Underage cost (C_u) = contribution margin + customer impact.
- Overage cost (C_o) = holding, markdown, or salvage gap.
- Critical fractile balances the two and sets the service target.

Newsvendor Mechanics

Critical Fractile Rule

$$q^* = F^{-1}\left(\frac{C_u}{C_u + C_o}\right)$$

- $F(q)$: forecast distribution for the selling window.
- C_u: cost of an unmet unit of demand.
- C_o: cost of a leftover unit.
- Service level target $= \frac{C_u}{C_u + C_o}$.

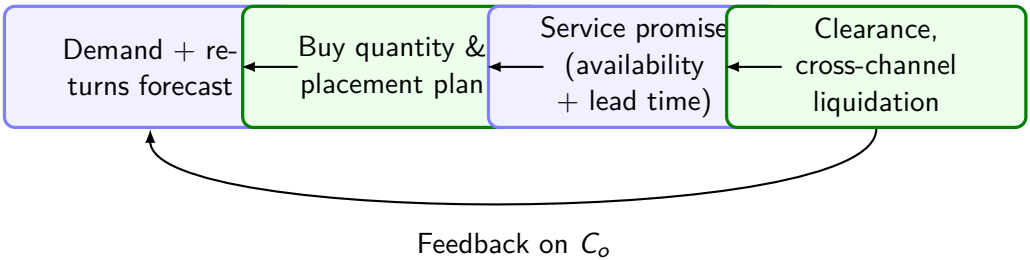
Flash Sale Example

Limited-edition gadget drop, priced at €120 with a supplier cost of €70 and liquidation value of €40.

Underage cost C_u (lost margin)	€50
Overage cost C_o (liquidation gap)	€30
Demand forecast	Normal$(900, 180)$
Critical fractile	$50/(50+30) = 0.625$
Optimal order q^*	≈ 958 units

- Decision: order 958 units to balance stockout risk and overage cost.
- Interpretation: target a 62.5% service level for this promotion.

From Model to Decisions



Out of Scope Today

Topics Parked for Later Deep Dives

- Feature-rich demand forecasting and machine learning pipelines
- Customer-level uplift modeling for personalization
- Automated parameter learning for C_u and C_o

Preview

These advanced methods will enrich the inputs to our classical models once we establish the baseline decisions and data flows.

Where the Model Strains

Demand shocks Seasonality and trend breaks can render $F(q)$ obsolete overnight.

Cost opacity Loyalty erosion and brand damage are tough to price into C_u.

Portfolio coupling Shared capacity across SKUs violates the single-period assumption.

Data hygiene Returns data and lead times require ongoing cleansing to stay credible.

Datasets We Are Scoping

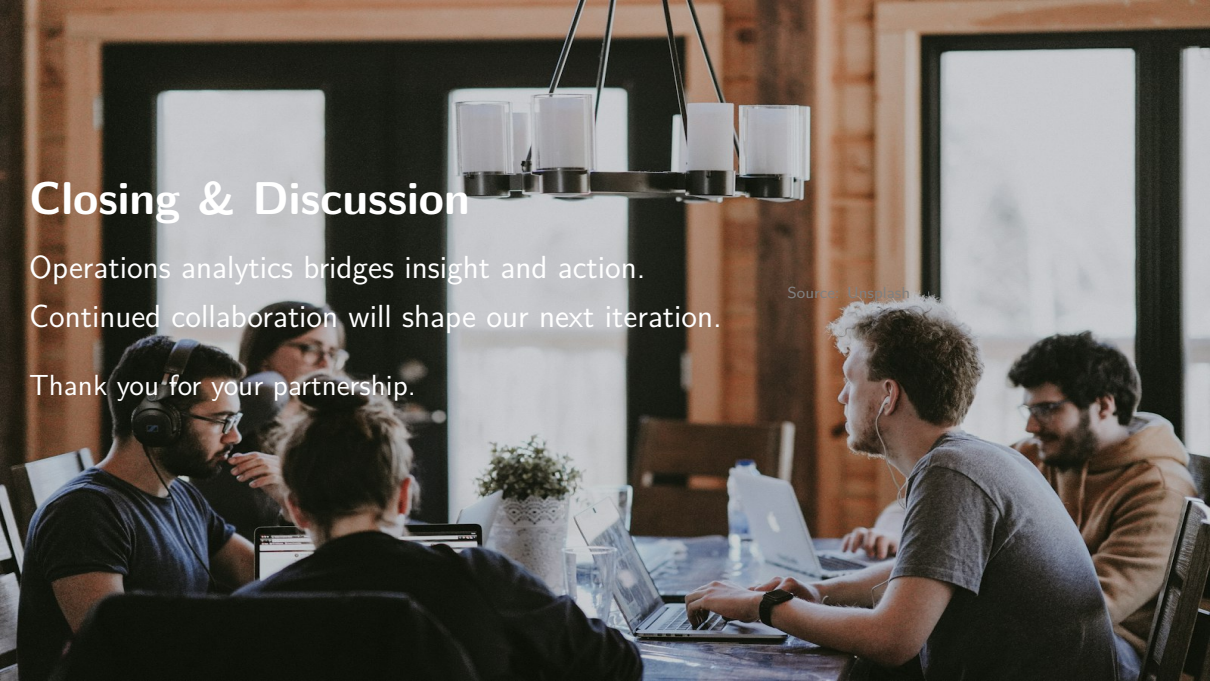
Dataset	Use Case
JD.com flash sale records	Demand and fulfillment volatility during high-pressure events
Amazon last-mile routing benchmarks	Link delivery promise to actual route constraints
Retail returns and refurbishment logs	Quantify net demand after returns and salvage value
Promotion calendar + fulfillment metrics	Calibrate C_u/C_o under different campaign types

Closing & Discussion

Operations analytics bridges insight and action.

Continued collaboration will shape our next iteration.

Thank you for your partnership.



References

- Velibor V. Mišić & Georgia Perakis, “Data Analytics in Operations Management: A Review,” *Manufacturing & Service Operations Management*.
- Wikipedia, “Newsvendor model,” `https://en.wikipedia.org/wiki/Newsvendor_model`.
- “Capstone Projects 121 & 122 2025–2026 Main Doc and Resources.”