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📄 Write-up: Hotel Bar Inventory Optimization System

What is the core business problem and why does it matter?

The hotel chain operates several bars across multiple locations. They face a recurring challenge of **stockouts** on popular items (leading to missed sales and poor guest experience), and **overstocking** on slower-moving items (causing waste, tying up cash, and increasing storage costs).

Why it matters:

- Maintaining the right stock levels directly impacts guest satisfaction, bar revenue, and operational efficiency.
- An optimized inventory ensures that bars can meet demand while minimizing costs and waste.
- Bar managers today rely heavily on intuition — our goal is to provide **data-driven forecasts** and **inventory recommendations**.

What assumptions did you make? Why?

- **Historical consumption patterns repeat** — We assume recent past consumption trends are indicative of future demand, especially for well-established bar operations.
- **Day-of-week effects** — Consumption varies by weekday vs. weekend, so weekly patterns are modeled.
- **No major external shocks** — No large promotions, holidays, or sudden policy changes are accounted for.
- **Lead time of 3 days** — Chosen as a typical supplier delivery window for a hotel bar chain.

These assumptions simplify modeling while still offering practical insights for managers.

What model did you use and why did you choose it? Why not others?

I used **Prophet** — a time-series forecasting model designed for business applications:

✅ Automatically handles seasonality (weekly)
✅ Adaptable to trends and changepoints
✅ Robust to missing data and outliers
✅ Easy to update as new data comes in

Why not other models?

- ARIMA/SARIMA: good, but tuning is complex and not scalable for 100s of items

- LSTM / Deep Learning: overkill for this simple use case and would require more data and compute
- Prophet offers a good balance of accuracy, interpretability, and simplicity for bar managers.

How does your system perform? What would you improve?

- The weekly forecasts closely match actual consumption patterns.
- The par level recommendations are practical and align well with typical inventory management practices.
- Managers can download actionable reports easily.
- The system is simple and works well in Google Colab.

Improvements:

- Add holiday/event calendar to improve forecasts for special days.
- Use "intermittent demand" models (e.g. Croston's) for very low-volume items.
- Include promotions and price effects as regressors.

How would this solution work in a real hotel?

- Bar managers upload daily/weekly data into the system (Google Colab or internal app).
- They view visual EDA to understand trends.
- They forecast demand for each item.
- They generate bar-specific inventory reports with par levels.
- They adjust purchase orders accordingly.

In practice, this would reduce stockouts, avoid overstock, and drive more consistent profits.

(Optional) What would break at scale? What would you track in production?

What would break:

- If new items appear frequently (cold start problem).
- If there are sudden large changes (e.g. new promotions).
- If data is missing or delayed from stores.

What to track:

- Forecast accuracy over time (MAPE, RMSE).
- Inventory turnover rate.
- Frequency of stockouts.
- Value of obsolete/waste stock.

✅ This is a practical, scalable solution that can be adopted by a real-world hotel chain to optimize their bar inventory and improve performance.