

Beverage Demand Forecasting & Inventory Recommendation System

1. Core Business Problem

A rapidly growing hotel chain operates multiple bars across various locations. They are currently facing two key inventory challenges:

- Stockouts of high-demand beverages, leading to customer dissatisfaction and lost revenue.
- Overstocking of slow-moving drinks, which increases storage costs and leads to wastage.

These issues are causing significant operational inefficiencies. To address this, hotel managers need a smart, data-driven forecasting system that:

- Predicts future demand accurately
- Recommends optimal inventory levels (also called par levels)
- Helps in reducing stockouts and excess stock

2. Assumptions

To simplify the model and make it practically usable, the following assumptions were made:

- Each Bar + Alcohol combination has a unique consumption pattern; hence, separate models are required.
- 7-day forecast horizon is selected, assuming managers restock weekly.
- Historical consumption is a strong indicator of future demand, with seasonality patterns being consistent.
- No external events (e.g., promotions, pricing changes) are considered in the forecast period.

These assumptions aim to balance realism and operational simplicity.

3. Model Choice

We used Facebook Prophet, an open-source time-series forecasting tool developed by Meta.

Why Prophet?

- Captures daily, weekly, and yearly seasonality
- Handles missing data and outliers robustly
- Scales easily across multiple time series (Bar + Item combinations)
- Requires minimal tuning and is designed for business use cases

Prophet is especially suited for quick deployment and practical insights for decision-makers.

4. System Output & Performance

System Output:

- 7-day forecast of beverage consumption per bar and drink
- Inventory recommendation = average forecast + uncertainty margin

Strengths:

- Generates realistic, interpretable forecasts
- Visual dashboards for trend understanding
- Scales well across many locations and products

Potential Improvements:

- Incorporate external factors like events, holidays, and weather
- Add reorder quantity logic, considering current inventory
- Track forecast accuracy using MAE, RMSE
- Enable automated retraining with new data weekly

5. Real-World Use Case

A hotel bar manager could use the system as follows:

1. Upload weekly sales data.
2. System generates 7-day forecasts for each beverage.
3. System recommends order quantities based on forecasted demand.
4. Manager downloads or views the report, then places orders.

6. Considerations at Scale

What Could Break:

- Too many time series (e.g., 200 bars 300 items) longer training and memory use
- Sudden demand spikes (e.g., events, promotions) not captured by history
- Data quality issues like missing or inconsistent entries

What to Track in Production:

- Forecast accuracy (MAE, RMSE over time)
- Stockout rate per item/bar
- Retraining duration and accuracy drift
- User feedback from operational staff and managers

This document provides a foundation for building, deploying, and scaling a demand forecasting and inventory optimization system in the hospitality domain.