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Booking Smarter, Planning Further

Forecasting Container Demand to Simulate Allocation Decisions



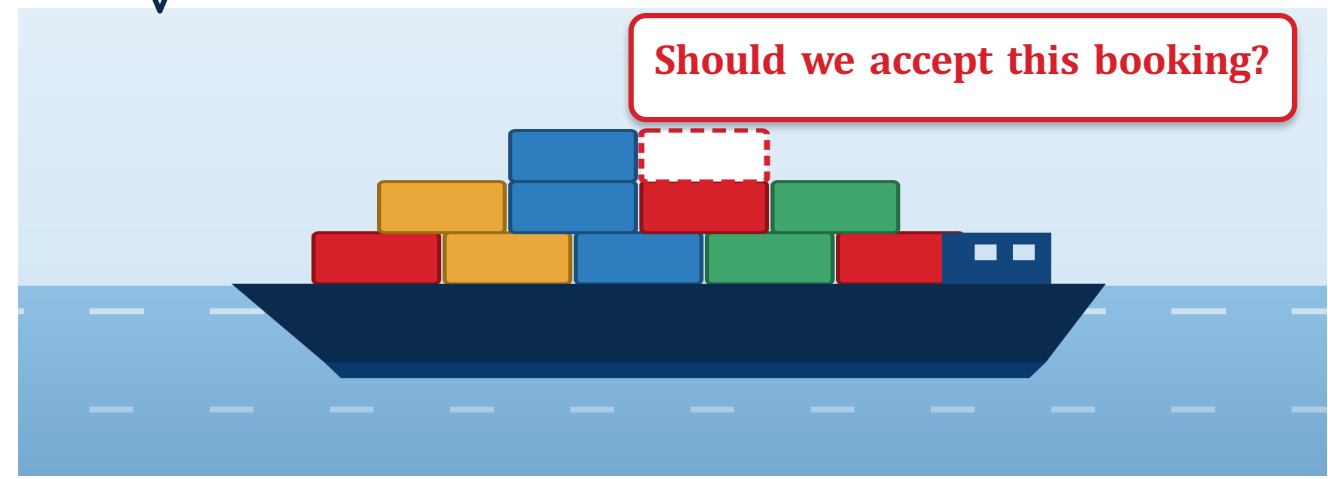
Ivy Xu

Linda Zhang

Problem Statement

MOTIVATION

A top 5 global shipping company, needs to decide which bookings to accept based on how much a ship can carry, using pre-defined business rules and economic policies. A ship's revenue depends on how full it ends up and which bookings the company accepted along the way.



Client

I'd like to book 2 containers from Los Angeles → Shanghai, departing Aug 31

Approved. You are a **protected contract customer**, so we accept this booking!



Client

Great. Can I also ship 40 containers from Los Angeles → Amsterdam the same week?

That one's less certain. Demand on that lane has been climbing since the recent tariff changes, so the ship may fill up — let me check the expected volume before confirming.



PHASE 1

Demand forecasting

PHASE 2

De-aggregation to synthetic bookings

PHASE 3

Booking allocation simulation

Objective



Forecast **demand for container** across the final 35 days before a ship departs



Rebuild forecasts that **match how real bookings arrive**



Let planners **test different allocation options** against realistic demand before committing

Phase 1 — Demand Forecasting

Data & Features



MAIN DATASET

Historical booking records



ADDED
Holiday data



ADDED
Trade data

Demand regime

Lane history

Booking velocity

Year-over-year Pattern

Top customer

Calendar

Market demand

Cargo mix

Customer type

Lane structure

Prediction Target:

How full each ship will be before departure

Methodology

Building the Dataset



Data Sources



Exploratory Analysis



Feature Engineering

Scoping Approach



Focus on **highest-volume lanes** covering 90% of booked container volume



Temporal Train/Test Split
Train on the past, test on later dates



Ensemble Model
XGBoost + LightGBM + CatBoost



Segment Analysis

+



Evaluation

By Business Zone
region / trade

By Lane Volatility
stable vs. volatile

By Demand Level
high vs. low demand

wMAPE

Phase 2 — From A Lane-Level Forecast to Synthesized Bookings



Every booking request will be accepted, held, or rejected by a set of **pre-defined business rules**

WHAT ARE THESE RULES?

The color-coded decision-making system:
green = accept **amber** = hold
red / **black** = reject

Phase 1 gives a **lane-level total** → Phase 2 **rebuilds this total into synthesized individual bookings**

EXAMPLE

PHASE 1

100 TEU*



SHANGHAI (ORIGIN)



LOS ANGELES (DESTINATION)

Predicted at 14 days before departure

Sampling + Rescaling Into

PHASE 2

Synthetic Booking A
60 TEU

Synthetic Booking B
40 TEU

* TEU = A standard shipping unit representing one 20-foot shipping container

How We Evaluate Accuracy: Weighted Mean Absolute Percentage Error

A score for **how far off our forecasts are, as a share of the volume shipped**. It is weighted, so a miss on a big lane matters more than that on a small one.

85%

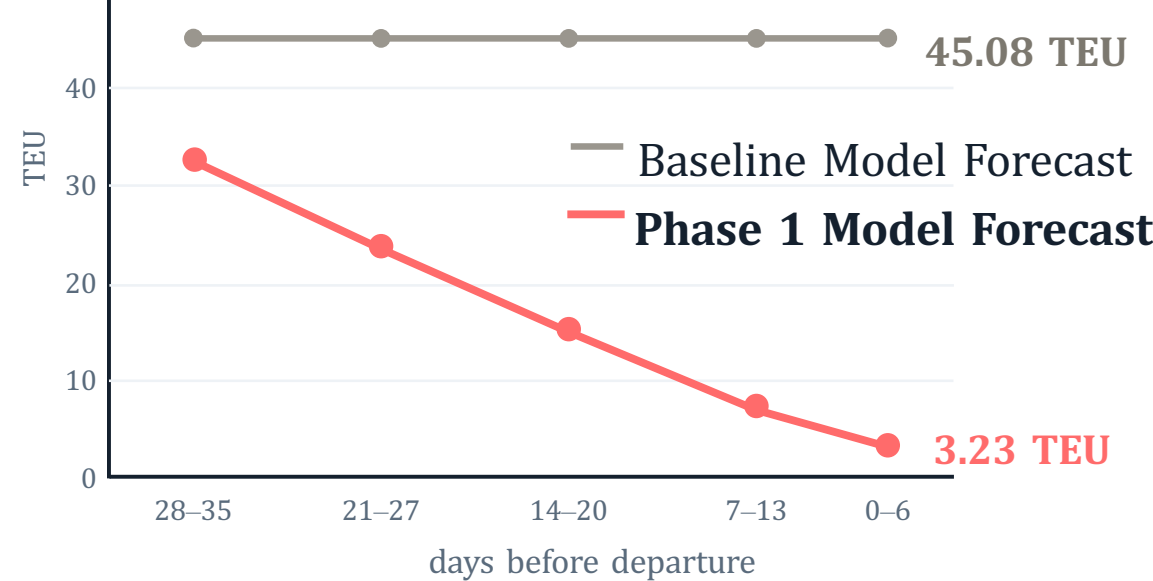


30.4%

Baseline Model
(using historical average demand)

Phase 1

Forecast error, measured in TEU, shrinks as departure nears



Business Impact

Fuller ships + Fewer missed bookings



More Revenue



60%
More Accurate Forecasts

Average forecast deviation decreases from 41.5 TEU to 16.6 TEU per shipping lane.



Better Demand Visibility

Forecast error reduction equivalent to approximately **24 twenty-foot containers** of demand per shipping lane.



Improved Capacity Utilization
= revenue potential

Seeing demand **35 days ahead** means the company turns away fewer bookings that could have fit → **previously unused spaces now generates revenue!**

Phase 3 — Allocation Simulation

Test the color-coded strategy on **synthetic booking from Phase 2** → Run through the company's **existing allocation system**, before any live deployment.

① COMBINED BOOKING DEMAND



confirmed bookings (received) synthetic bookings (Phase 2)

② EXISTING ALLOCATION ALGORITHM

Commercial Allocation

Is there room left in our long-term contract on this route?

Customer Allocation

Has this customer used its?

Color Match

Pick the strategy for this voyage

Consolidate

Result in one decision

Accept

Extra Space Request*

Reject

* ESR (Extra Space Request): a special-approval channel where select facilities accept shipments on behalf of tenants, mainly for business or commercial storage.

* OK / ESR / KO = accepted / special-approval / rejected. Simulation reproduces production behavior exactly; only future demand is synthetic.