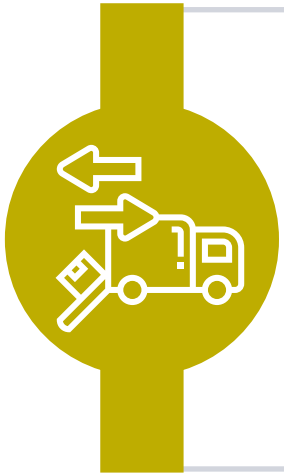


Minimum Baseline Demand Forecasting and Dispatch Planning

(Less-than-Truckload (LTL) Provider)

Estimated the **lane-wise baseline demand** and provided **a forward-looking dispatch plan** to procure and pre-allocate transportation resources at lower cost and effort

Demand Forecasting and Dispatch Planning for a Less-than-truckload (LTL) provider

ABOUT THE CLIENT: Client is a US based transportation and logistics solutions provider operating primarily in less-than-truckload (LTL) services.

SITUATION

- Client **did not have visibility into their recurring demand** and were **procuring all the necessary transportation resources on an ad-hoc basis** and at short notice leading to relatively **higher costs and significant man-hour investment** from the planning team.
- Partnered with the client **to analyze the demand patterns for each lane and build a demand planning tool** which provided the forward-looking baseline demand at each lane that can be planned for in advance.

INPUTS

VALUE ADDED

- **Analyzed the historical** lane-day level dispatch volumes and benchmarked the lanes based on their volatility (very low to very high). Calculated a custom percentile for each volatility bucket across each day of the week based on the allowed over-forecast limit for the bucket. Captured the seasonality (weekly, yearly) of demand in each lane and arrived at the baseline demand for each lane-day.
- **Built a time-series model to forecast the minimum baseline demand** for each lane based on the historical dispatch volumes.
- **Integrated the option to view grouped or individual lanes** based on a destination grouping provided by the client. This **yielded improved forecasts for grouped lanes** where individual lanes did not have sufficient dispatch activity for reliable planning.
- **Developed and delivered a dispatch planning model** using the time series forecast when the volatility method predicted zero demand

PROCESSING

IMPACT

- The dispatch planning tool **enabled the client to identify and plan for the baseline demand across lanes, at a potentially lower cost**.
- The tool **covers ~55% of the total dispatch volume** and could **potentially reduce their shipping costs by up to ~10%**, in addition to the planning man-hours saved.
- The **client's execution team could focus** their efforts on the **procurement of additional transportation assets required for the day in lanes with higher variability**.
- The client was also able to **identify terminals with sub-optimal performance** in dispatch KPIs and take measures to improve operational efficiencies and optimize costs.

OUTPUTS

Forecasting Using Historical Recurring Demand

Objective

- **Generate minimum baseline demand** for each lane from the historical daily dispatch volumes using **pattern recognition of recurring consistent demand**

Approach

- **Categorized the lanes into different volatility buckets** (Very Low to Very High) based on variance in demand for each day of the week
- **Identified threshold for minimum baseline demand** by ensuring that the over-forecast (OF) days[1] for the lane-day combination is within the limit f the volatility bucket
- **Ran multiple limit OF days scenarios by excluding outliers** to determine optimum combination of coverage[2] and OF days
- **Included seasonality** (weekly, yearly) of demand as part of the prediction
- **Summarized the recurring baseline demand** for each lane, by day of the week

ILLUSTRATIVE

Recurring demand by lane, based on threshold identified							
Lane	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Lane 1	1	4	2	4	3	2	0
Lane 2	2	2	2	2	1	0	0
Lane 3	1	2	2	1	2	1	0
Lane 4	0	2	2	1	1	0	0
Lane 5	2	1	1	1	2	0	0
Lane 6	2	2	2	2	2	0	0
.....							

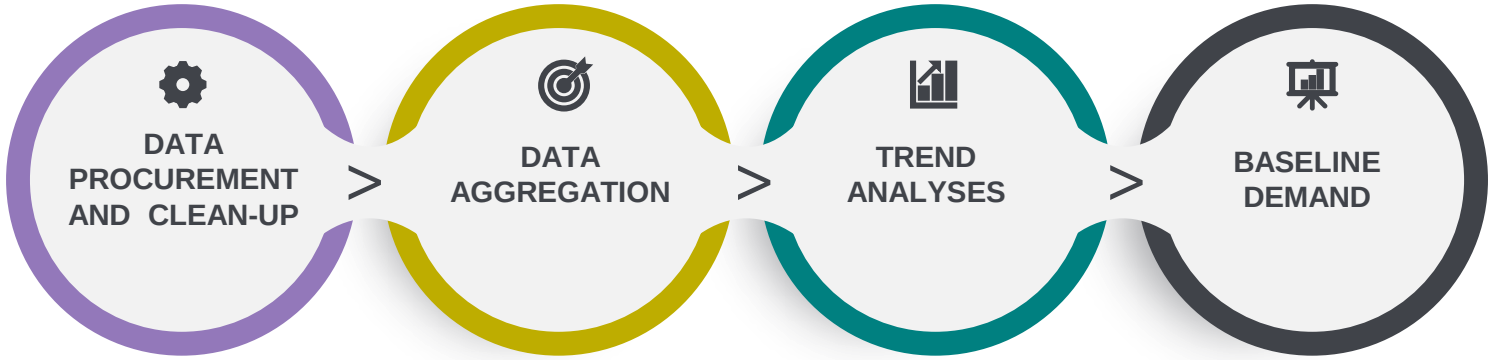
Model config[3]	Coverage	Overforecast volume	Overforecast days
Config 1	42.7%	3.1%	1.8%
Config 2	45.4%	3.6%	2.2%
Config 3	48.0%	4.3%	2.8%
Config 4	45.9%	3.7%	2.3%
Config 5	44.2%	3.4%	2.0%

Forecasting Using Historical Recurring Demand: Methodology

ILLUSTRATIVE

- Assessed manifest level data consisting of origin, destination, revenue, cost, PROs, dispatch ready time, dispatch time
- Assessed PRO level data consisting of pick-up, drop-off, trip #, revenue
- Merged the data sets to separate trips with multiple stops into individual legs with mutually exhaustive set of PROs

- Analyze the trip patterns for each lane and day of the week, to identify the volatility in demand across the each lane-day
- Assessed the patterns for ~1.5 years data
- Ran scenarios for allowed over-forecast days by excluding outliers to determine min baseline demand



- Aggregate the data by unique lane and 'shipment ready date' to determine demand time series for each lane

- Create summary of recurring demand at each lane, by each day

Recurring demand by lane

Lane	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Lane 1	1	4	2	4	3	2	0
Lane 2	2	2	2	2	1	0	0
Lane 3	1	2	2	1	2	1	0
Lane 4	0	2	2	1	1	0	0
Lane 5	2	1	1	1	2	0	0
Lane 6	2	2	2	2	2	0	0
.....							

Forecasting Daily Demand Using Time Series Models

Objective

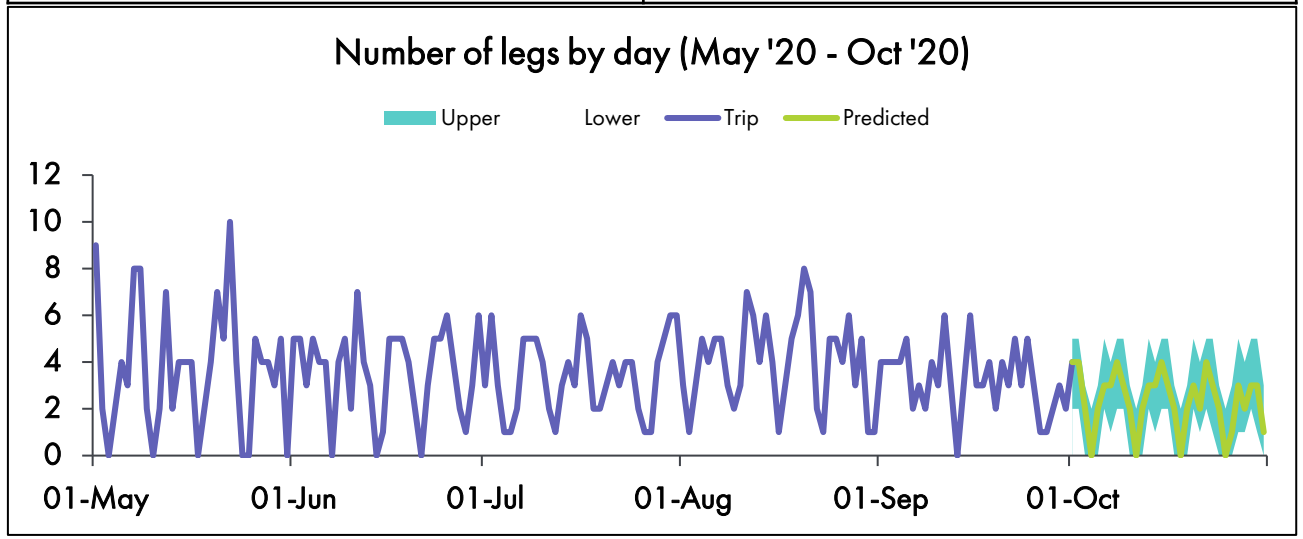
- Generate **minimum baseline demand** from the historical daily dispatch volumes using **time-series forecasting**

Approach

- **Considered data** for the **same time window as pattern recognition method**, adding a calendar as an external regressor
- **Identified time-series models** suitable for the data e.g., SARIMAX, TBATS, FBProphet
- **Calculated the lane-wise lower bound** of confidence intervals based on the **acceptable over-forecast threshold** for the test dataset for the best model for each lane
- **Forecasted the expected baseline demand** for each lane for the next two weeks
- **Merged results** from the time-series forecast with the results from the **pattern recognition method**, giving priority to the latter

ILLUSTRATIVE

Forecasted minimum number of legs	
Date	Min. # of legs
01-Oct	2
02-Oct	2
03-Oct	0
04-Oct	0
05-Oct	0
06-Oct	2
07-Oct	1
08-Oct	2
09-Oct	2
10-Oct	0
11-Oct	0
12-Oct	0
13-Oct	2
14-Oct	1
15-Oct	2



Forecasting Daily Demand Using Time Series Models: Methodology

ILLUSTRATIVE

DATA PREPROCESSING AND EXPLORATION

- Clean up data by removing outliers, duplicates etc.
- Identify daily demand for each lane
- Check for patterns such as seasonality, trends etc. in the lane data for the selected lanes

MODEL TRAINING AND EVALUATION

- Identify time-series model suitable for the data e.g., SARIMAX, TBATS, FBProphet
- Split the data into train and test and evaluate model performance using metrics like MAE, R-squared
- Select the best model for the data

FORECAST LANE WISE DEMAND

- Identify the lower and upper bound confidence intervals based on acceptable over-forecast threshold for the best model for each lane
- Estimate minimum demand using the lower bound

LANE WISE BASELINE DEMAND

- Create forecast using the optimal lower bound for each lane
- Merge results from forecast with results from recurring demand analysis

Lane 1 Time series forecast using Time Series Models – 0% over-forecast days