Fleet and Service Optimization

Assigning right sized ship to the right service
Dynamic Optimization maximizing contribution

Right Ship
Right Service
Maximizing Contribution
Motivation

- **Maximizing profit**
- **Intense competition** in the Liner Shipping
- **Widening gap** between Supply and Demand
- Impacting **Operations and Commercials**
- Affecting **profitability**!
Problem Statement
Current Day Challenges - Liner Industry

- Extreme Competition
- Trade Wars
- Economic Instability
- Supply and Demand Imbalance
- Soaring Fuel Prices
- Demand for continuous innovation
Study Conclusion

1. Freight rate exerted a statistically significant positive effect on the shipping company’s profits.

2. Bunker fuel prices which were the most significant element of the shipping company’s operating costs imparted … statistically negative impact.

3. …impacts of economics of scale and of the chartered vessel ratio out of the total tonnage of ships … at best obscured effects on the company’s profits…
Supply and Demand Imbalance

The demand curves for 2 trades China-USWC (red) and China- South America (Green) with negative correlation- Index fluctuating between 1000 & 2000

Dynamic Trade - Rates and volumes volatility in the Liner Trade

Supply and Demand not matching, due to imbalance.

Dynamic nature of the trade, means the shipping lines have to constantly change their proforma schedules to match the cargo flow.

Figure left- China-South America Trade and China- US Trade with a negative Correlation ship in the freight.

SOURCE: Shanghai Container Freight Index
Commercial Impact

The month on month drop in the scheduled Teus / container vessel calls in China port (Dec 2017 till Mar 2020)

Commercial imbalance-Drop in demand
Adjusted by the Liner companies by having blank sailings, by idling their ships.

Commercial Impact
Schedule reliability is lost, impacting the customer confidence.

Rerouting of vessel – Via Cape instead of Suez
With bunker prices at the lowest, lines route ships via cape to reduce the impact of Suez canal cost

Constant Change in vessel operations to match demand
The figure (left) shows the month on month, steep fall in the scheduled container vessel calls (blue line) in the Chinese port. Additionally the scheduled teus (red line) is gradually falling, indicating large size vessels being deployed in the trade.

Bunker Optimization

Bunkers form 40% of the vessel cost and to minimize the cost, strategy such as Slow steaming of vessel / Vessel Idling / Vessel layups are followed.

Operational Impact

Export cargo has to be shut out, import cargo has to be rerouted with external feeders and the change, impacts not only the shipping lines but the customer and the terminals.

Schedule reliability

Continuous adjustment in the vessel positioning into different service or idling, which results in drop in the Scheduled reliability.

The volatility in the price of Bunker at Rotterdam (orange) and Singapore (Green). The Fuel cost forms 40% of the Liner Cost

SOURCE: https://shipandbunker.com/
Response from Liner companies to Challenges

So how does a Liner company maintain a cost efficient and stable liner schedule network and ensure schedule reliability?

Objective => Maximizing Contribution (Profitability)

By putting
a. the right sized vessel and
b. Minimizing fuel, charter and port cost
c. On the service with right port calls
d. With right cargo composition (Teus / Weights / contribution)
e. With proper empty repositioning and vessel utilization
f. And most of all –at the right time (freight rates are function of time / seasonality)

Defining Constraints
Vessel size, cargo demand, Port, MT container supply, route constraint, operational constraint, commercial constraint, tides, Draft limitation, berth window constraints are satisfied and the vessel maximizes contribution.
Challenges in vessel allocation, satisfying cargo demands and schedule generation – Case Study of Liner Ship

- 1500 Port Pairs
- 60 Ships (500 / 4000 Teus)
- 10 Commodity Type
- 6 Equipment Type
- Daily Fluctuating Demand
- Multiple Port Discharge
- Port Depth Restrictions / Varying draft

Variables:
- Which Ship?
- On what Service?
- Loading what Port Pair?
- What Commodity?
- What Quantity in Teus / Tons?
- What Equipment Types?
The Functionality
5 Step process
Cloud based Optimization solution for Liner Companies

5 Step approach from planning to implementing solution

**PLAN**
Plan what services / vessels / ports / Cargo to optimize

**CONNECT**
Connect data to cloud using Restful API

**OPTIMIZE**
Run the Optimizer and generate Result

**ANALYZE**
Analyze the output schedule plan, and profitability

**APPLY**
Apply the generated solution to client production
PLAN

Planning service
Vessel
Port call
Demand

4 stage solution
PLAN STAGE 1

Defining the Proforma Service with port rotation

Proforma Service

1. Port rotation
2. Distance between each port legs
3. Vessel speed for each leg
4. Terminal Productivity
5. Port stay in Days
6. Total Sea Time
7. Maneuvering time
8. Service Frequency
Defining the vessels and the vessel fixed Costs on the Service

Defining Vessel on Service & Cost

1. Listing down vessels
2. Defining the vessel details
3. Fuel Consumption @ Speed
4. Charter Hire Cost
5. Port Cost
6. Canal Cost
7. Insurance and Maintenance
8. Vessel Max / Eco Speed
9. Fuel consumption
10. Bunker Cost
Defining the Port pair with LB and UB Teus and Weight Range with Contribution by port pair.

What port pair & equipment types can be served with min and max bounded range?

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<th>Teus Upper Bound</th>
<th>WT Lower Bound</th>
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Defined nodes and Edges of the Network routing

PLAN STAGE 4: Applying the Vessel and Port Constraint
Connecting to Optimizer (API) & running the API service
API Framework for Connecting to client application data to Optimizer

CONNECT

API Documentation & Details for connection

- API Description
- Resource URL & Info
- Response formats
- Authentication Type
- Security JWT
- Token refresh
- API Validation
- API Parameters
- Success Response

API details as received from client application for connectivity to cloud based Fleet Optimizer application
OPTIMIZE Stage

Running the optimizer
**Objective function**

Maximize the contribution profit

\[ f(x_1, x_2, \ldots, y_{11}, y_{12}, \ldots) = g(x_{m_j}) \cdot l^{(m_k)}(x_{m_j}) \cdot y_{j1}^{(m_k)} + V_{0, i}^{(m_k)}(x_{m_j}) \cdot y_{j2}^{(m_k)} \]

\[ \forall k, l, m \in N \]

\[ \forall x_{m_j}, y_{j1}, y_{j2} \in W \]

\[ g(x_{m_j}) \] is the function of contribution per Teus of \( m \)-th port pair of \( k \)-th service.

\[ V_{0, i}^{(m_k)}(x_{m_j}) \] is the vessel operating expenses for \( i \)-th vessel in \( j \)-th service.

\[ h() \] is the number of port pairs in \( j \)-th service

\[ o() \] is the number of ports in \( k \)-th service

\[ Q(i) \] Max allowable weight in Tons of \( i \)-th vessel.
ANALYZE Stage
Generating and analyzing the result
The generated output, after running the optimization:

### Financial Profitability

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<th>Item</th>
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<th>Prev. Trend</th>
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<td>Material TEUs</td>
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<tr>
<td>Bankrolled TEUs</td>
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<td>Total TEUs</td>
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<td>Total Revenue</td>
<td>1,979,781</td>
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<td>Variable Cost</td>
<td>(274,965)</td>
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<td>Net Revenue</td>
<td>1,704,816</td>
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<td>Vessel Fixed Cost</td>
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<tr>
<td>Total</td>
<td>573,157</td>
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### Commercial Plan
- **VARIABLE COST**: 2019-AUG (108,676)
- **Total profit for the month**
- **Profit by Service and vessel**
- **Total contribution for the laden**
- **Total vessel operating cost**
- **Total vessel Repositioning cost**
- Which Port pairs to be served with Teus and which customers to be targeted!
- Vessel utilization by Teus and Weight
- No of Teus to be loaded between various port pairs
- Total no of 20s/40s /HC/Rfr to be loaded for each port pair
- Total tons (weight) loaded between various port pairs
- Satisfied all port pairs within LB and UB range
- Maximized the lifting on board the vessel
- Negative Contribution services /port pairs identified and minimized

### Operational Plan
- **TOTAL REVENUE**: 2019-AUG (1,817,843)
- The vessel schedule with the port rotation and schedule date of calls at port.
- The vessels planned for the service
- The total vessel costs for the vessel on each service, with breakup by Bunker, charter hire, port cost and Canal cost.
- Vessels with greater capacity (Teus) were used on port pairs with greater demand (Higher UB Range)
- Excess Vessels identified were off-hired

### Empty Equipment plan
- **CONTAINER COST**: 2019-AUG (144,511)
- The empty repositioning plan between surplus to deficit port
- Empty lifting by each vessel / voyage within the stock limit
- Surplus and Deficit status before and after the empty repositioning
Solverminds Team / Product and Experience

**Optimization in the Liner Shipping**
- Container vessel Stowage Optimization
- Liner Fleet Optimization
- Vessel Scheduling Optimization
- Equipment repositioning Optimizer
- Vessel utilization with Customer & Cargo selection
- Maximizing intake of laden Teus, Reefers and empty Teus
- Route Network Optimizer

**Bulk Shipping**
- Bulk Ship cargo, fleet Planning and scheduling
- Bulk carrier loading maximization

**Logistics**
- Optimising warehouse number and location planning

**Airlines Industry**
- Ground staff Rostering

**Optimization for Oil & Tanker Industry**
- Fleet planning, scheduling and optimization software
Optimization Expertise & Team

**Optimization Programming expertise**
- Linear Programming
- Mixed Integer Programming
- Mixed Integer Linear Programming
- Mixed Integer Non Linear Programming
- Heuristics algorithms

**AI and Machine Learning Platform**
- AI/Machine Learning algorithms
  - Gradient Boosting / SVM / KNN / Random Forest
  - Data wrangling platform
  - Connect platform to GCP / Sage maker
- Deep Learning Algorithm
  - Convolutional Neural Network
  - Recurrent Neural Network / LSTM
  - NLP and Text Analytics

**Cloud-based solution**
- Software as a service (SaaS)
- Subscription
- Data integration with REST API
- ETL Platform for data export & transformation
- HTTPS for security

Team of **20+ professionals** with varied experience in large scale optimization model

Team with more than **17 years of experience in Optimization, application development and AI / Machine Learning** for the Shipping Industry

Team with **25+ years experience in Liner, Bulk, Tanker and Logistics industry**
Thanks