

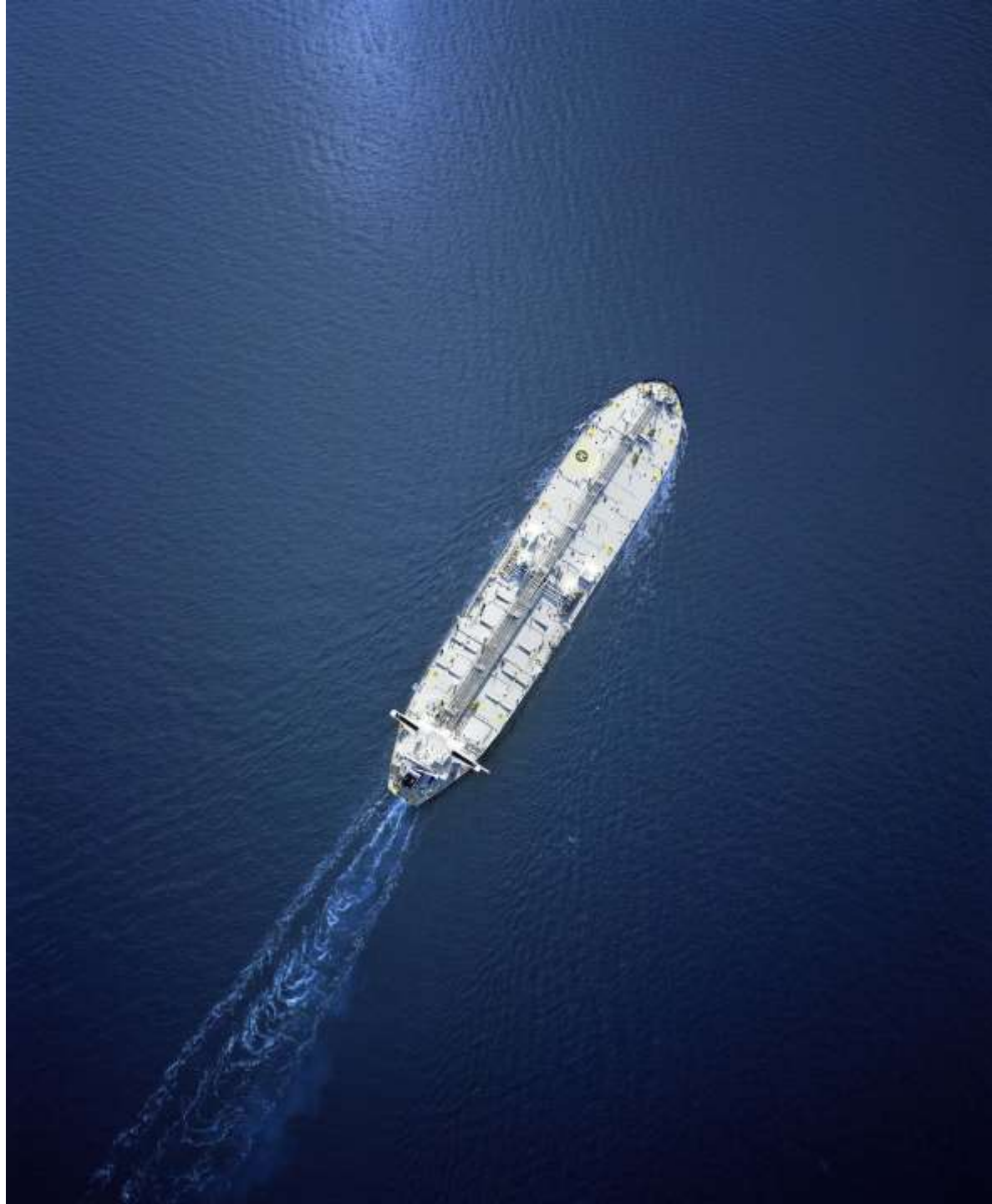


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Machine learning use-cases in vessel supply chain management

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Thenamaris (Ships Management) Inc.

September 2019



Thenamaris at a Glance

A brief history of the company thus far

49

years experience
in ship management

93

Vessels under management
(including LNG and LPG carriers)

2,900+

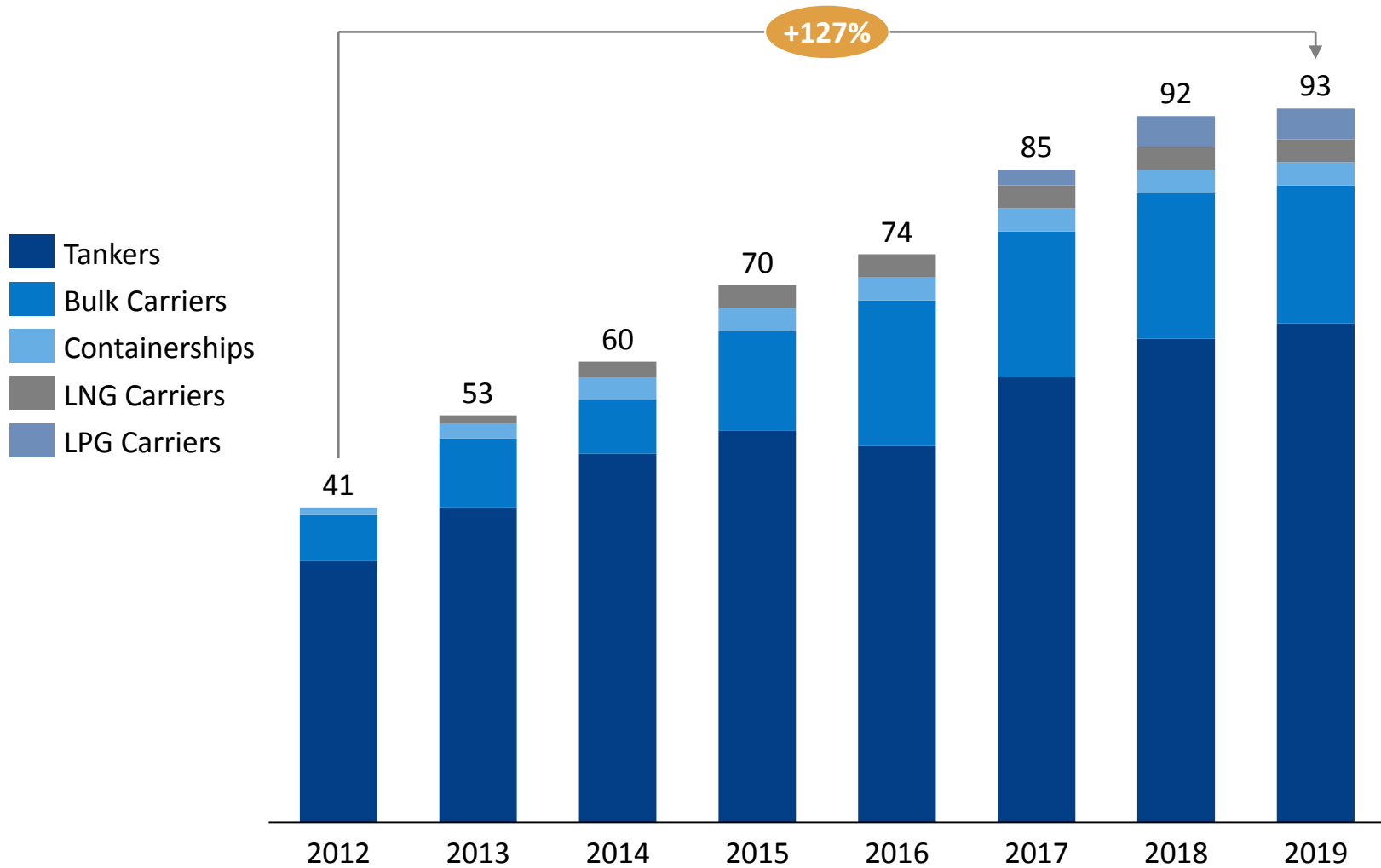
Seafarers

300+

Shore-based employees

Our strategic objective is to safely and profitably grow

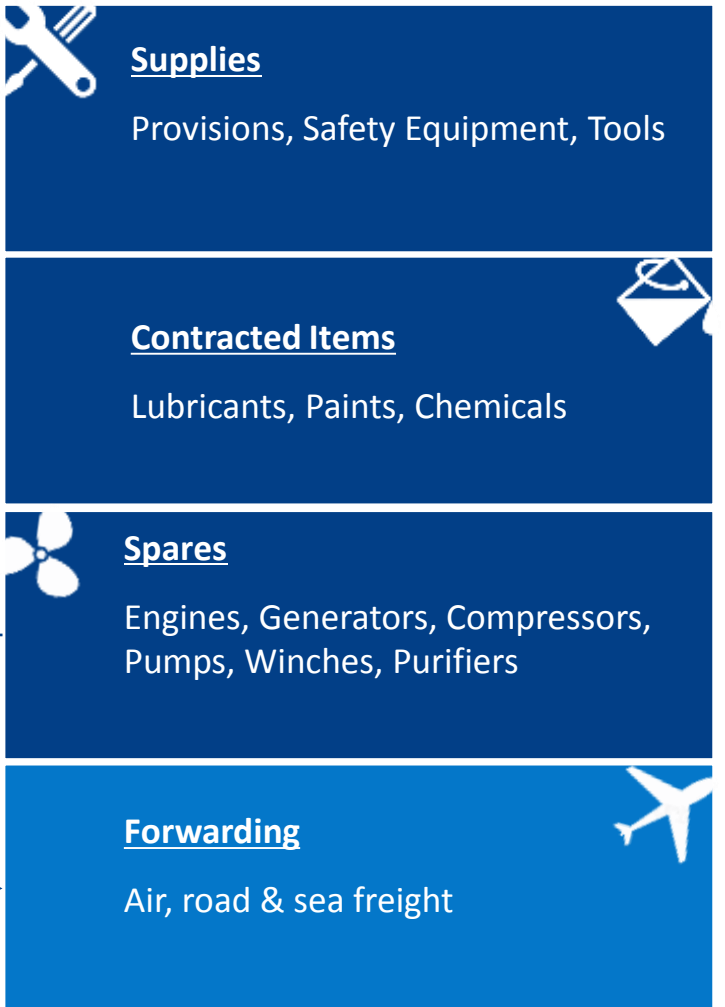
Whilst managing a young fleet with an average age of 8 years



Structure of Operations

Category Management: Separating purchases by operation allows achieving economies of scale

Day-to-day operations



Indicative Thenamaris 2017 tanker running expenses vs. peer average *

-14% Consumables **-17%** Lubricants

Supporting Sections



Analysis Team

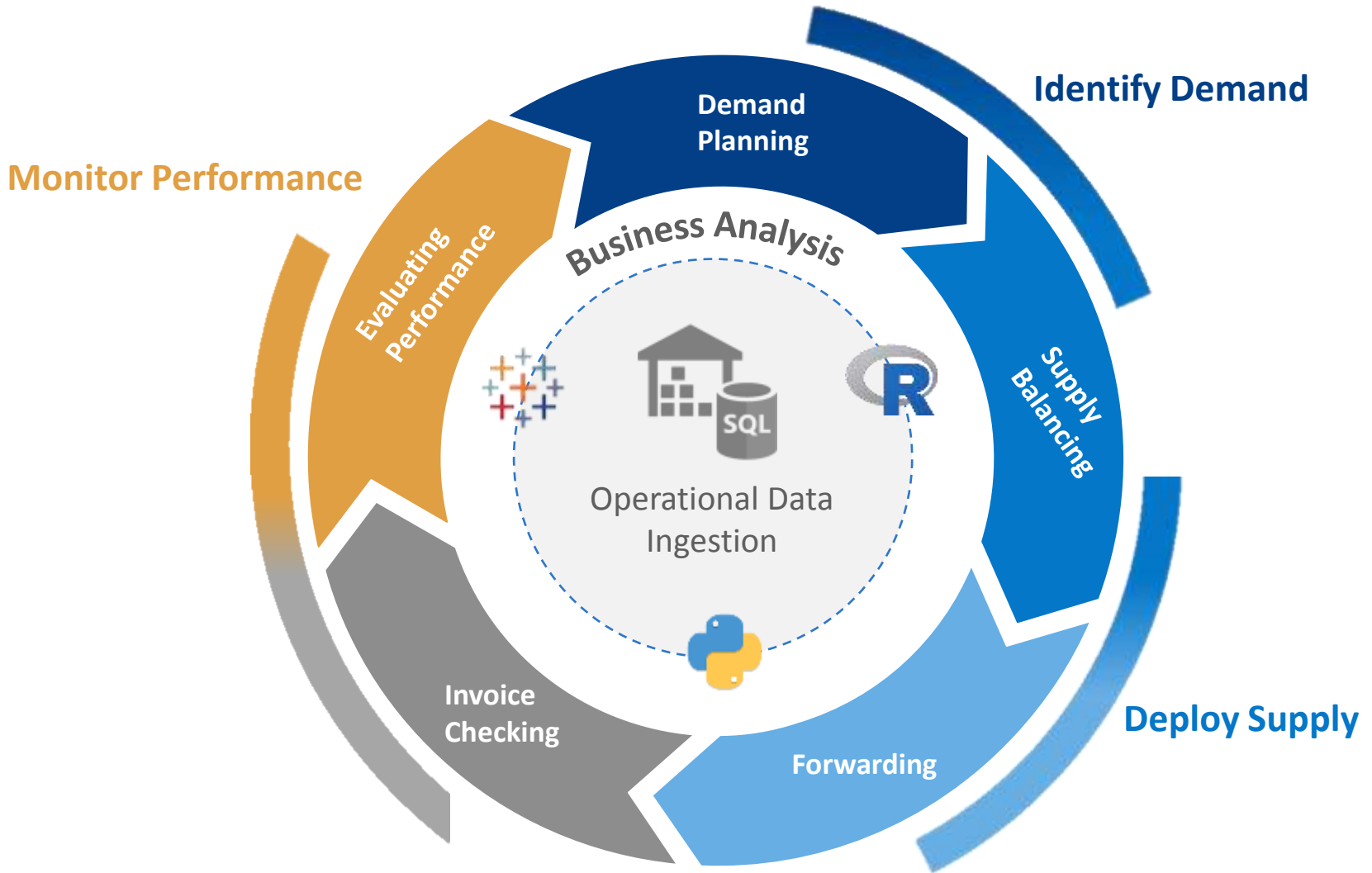
Reporting & Advanced Analytics

***Source:** BCG Shipping Benchmarking Database 2018, Comparing performance of 49 of Thenamaris vessels to 1203 competitor vessels

Notes: Cost category performance calculated as weighted average

Operational Data Ingestion

Supply Chain Optimization with Advanced Analytics & Machine Learning

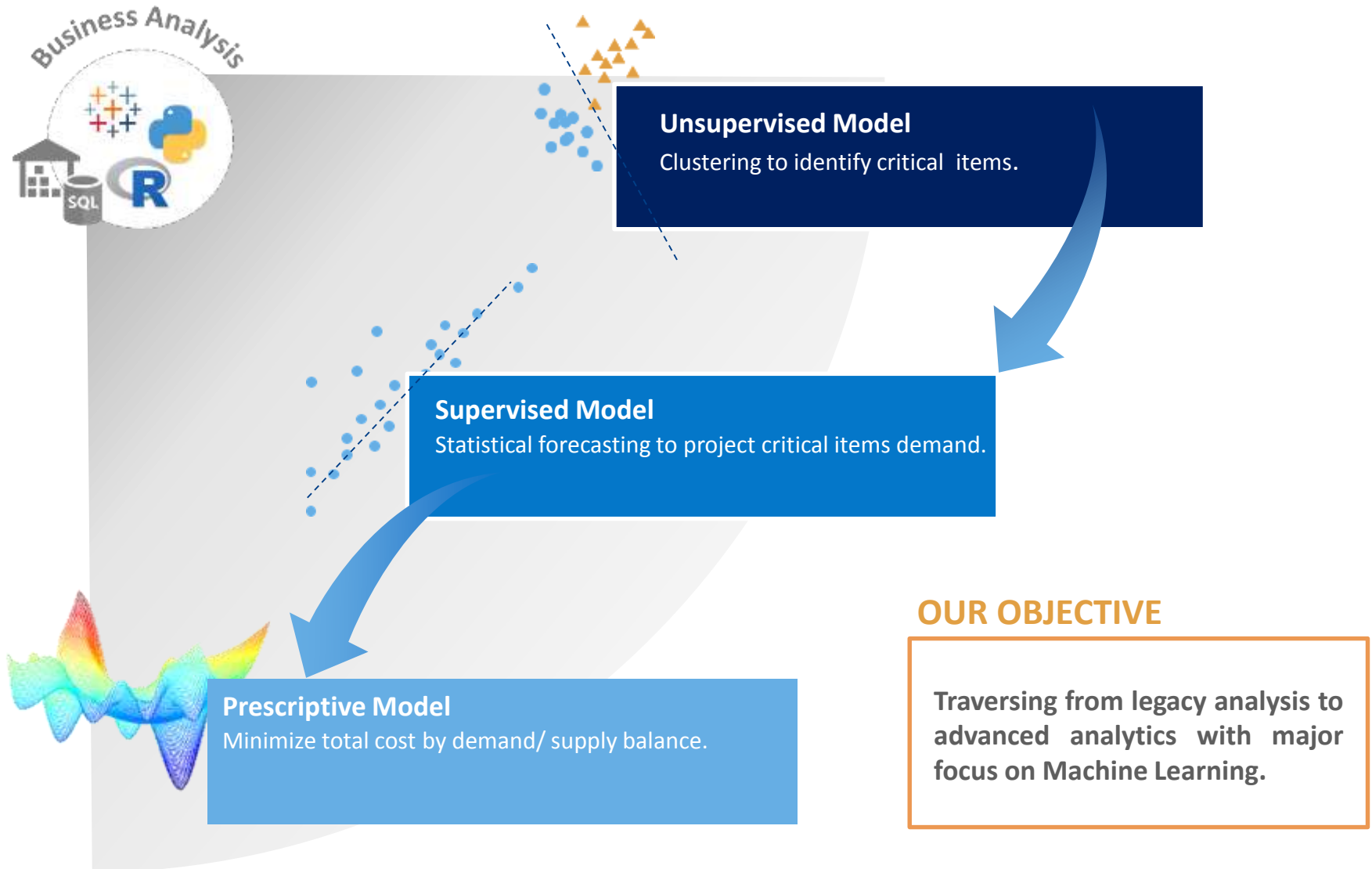


Machine learning framework

Unsupervised, supervised & prescriptive modeling

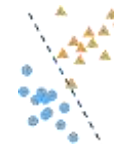


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Clustering & identifying critical items

2-step approach for provisions, spare parts and consumables

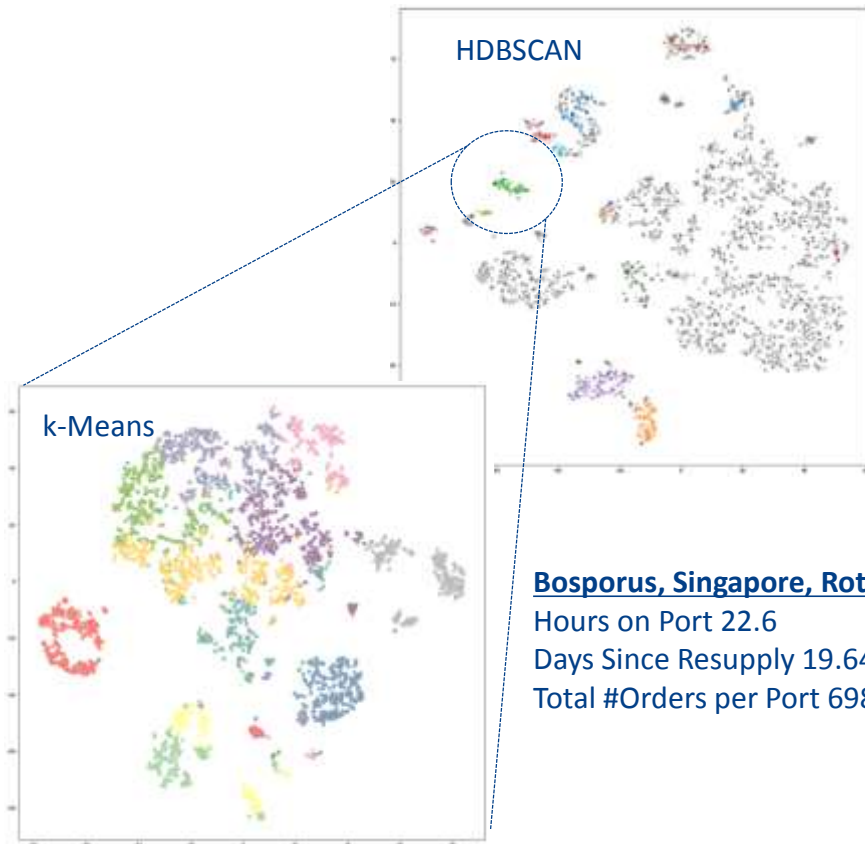


Unsupervised
Model



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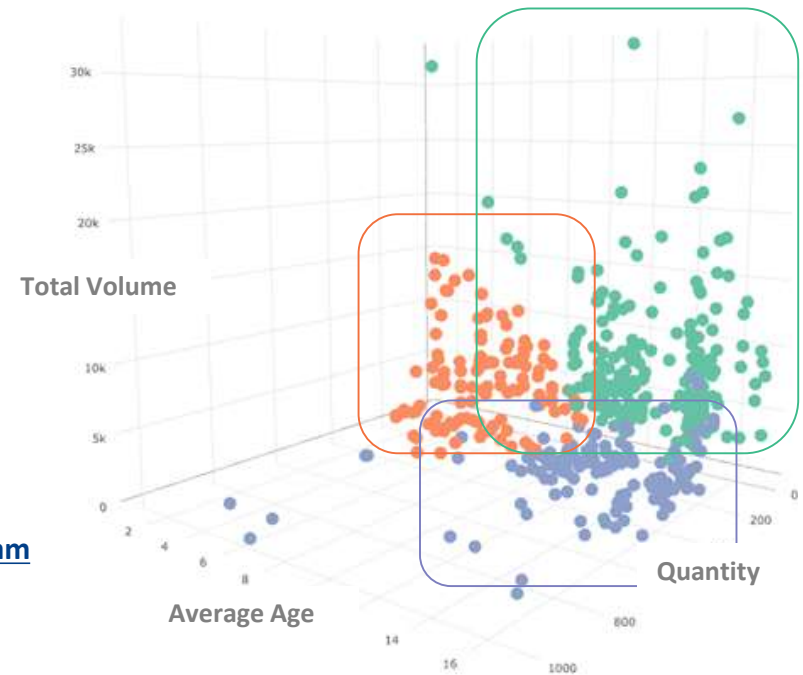
Critical provisions port calls



Bosporus, Singapore, Rotterdam
Hours on Port 22.6
Days Since Resupply 19.64
Total #Orders per Port 698

Critical consumables & spare parts items

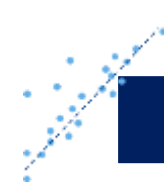
DBSCAN & k-Means



- High total volume – older vessels
- High total volume – younger vessels
- Low total quantity – low price

Forecasting critical items

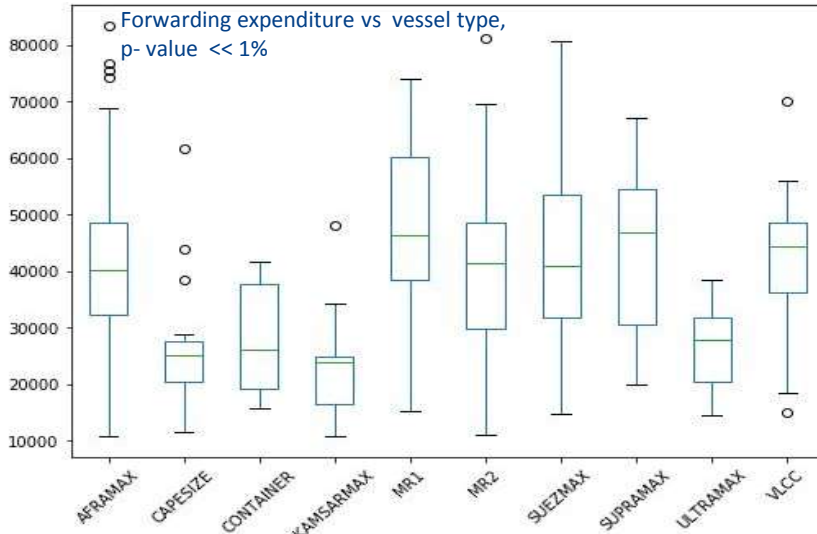
Implementing in consumables, forwarding & spare parts bulk orders



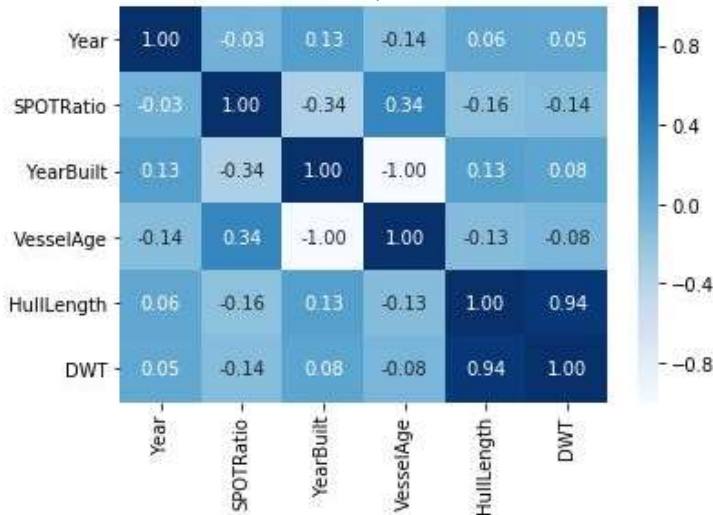
Supervised Model



Exploratory Data Analysis



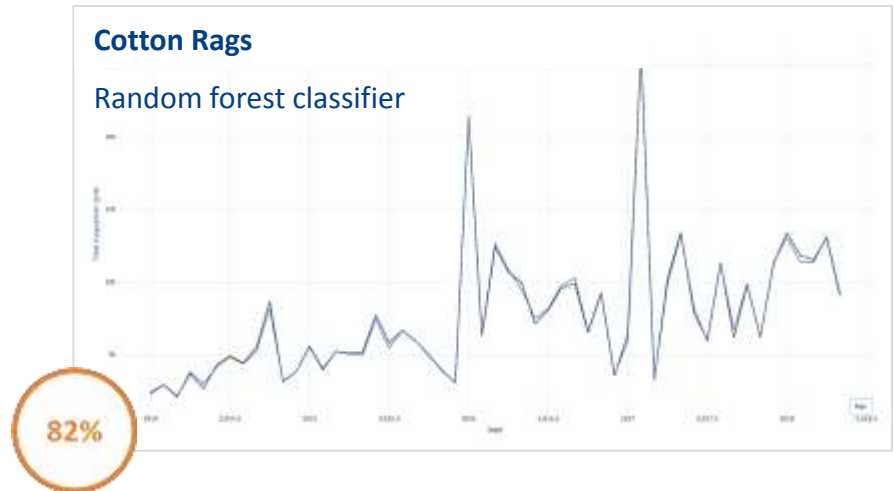
Correlation matrix of independent variables



Critical deck & engine consumables demand

Cotton Rags

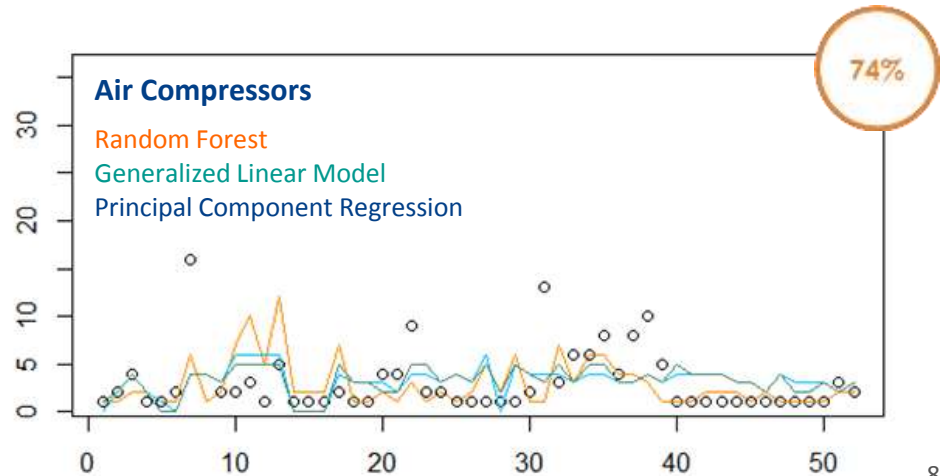
Random forest classifier



Critical ME, DG, Compressors, Purifiers demand

Air Compressors

Random Forest
Generalized Linear Model
Principal Component Regression



Cost minimization

Total cost minimization for consumables, provisions & spare parts



Prescriptive
Model



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Objective Function

$$\min(\text{Total Cost}) = \sum_{\text{items}} \sum_{\text{vessels}} (\text{Acquisition} + \text{Forwarding} + \text{Inventory} + \text{Stock-out})$$

applicable across consumables, provisions & spare parts

Decision Variables

- Service level
- Price
- Lead time

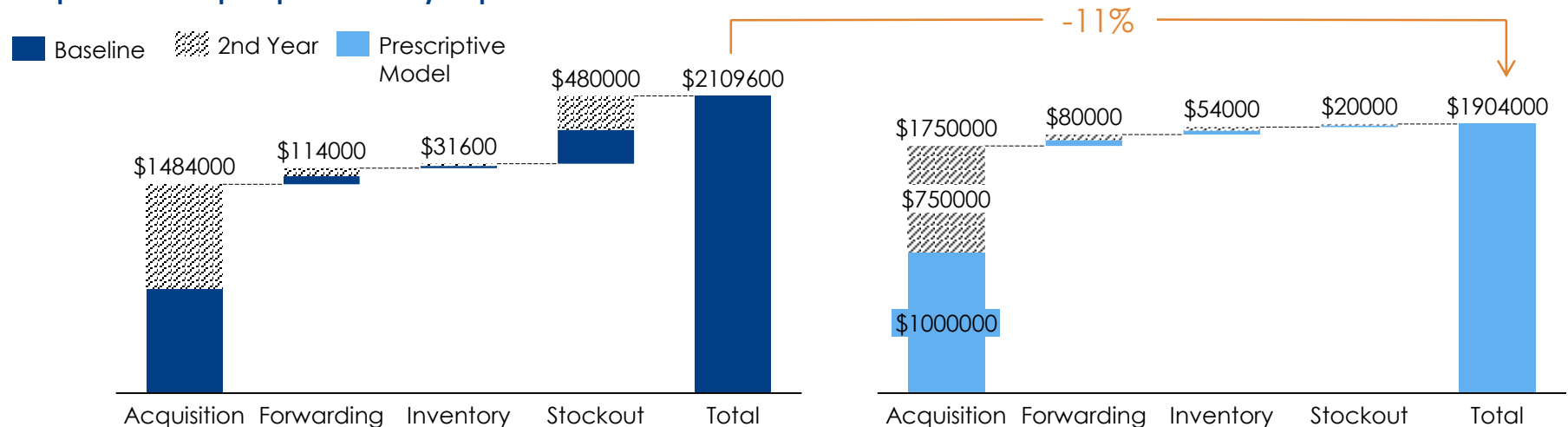
Constraints

- Nominal quantities
- Delivery Times
- Vendor shore splits

Alternate Scenarios Assessed

- Unconstrained cost minimization
- Vessel age split
- Focus on OEMs

Bulk purchase for spare parts over 2-year period



*numbers are indicative / benefit is realized